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Hepaticae of Puerto Rico

IX. BRACHIOLEJEUNEA, PTYCHOCOLEUS, ARCHILEJEUNEA, LEUCOLEJEUNEA, AND ANOPLOLEJEUNEA

ALEXANDER WILLIAM EVANS

(WITH PLATES 6–8)

BRACHIOLEJEUNEA

The genus *Brachiolejeunea* includes between twenty and thirty recognized species. About half of these are American, the others being found in eastern Asia or among the islands of the Pacific. No species has as yet been reported from Africa. Although essentially tropical in its distribution, the genus reaches its northern limits in Florida and Japan and its southern in Australia and Patagonia. Since the first species described by Spruce is *B. laxifolia* (Tayl.) Schiffn., this may be considered the type of the genus. It was originally described from specimens collected by Jameson in Ecuador but is now known also from Bolivia.

With scarcely an exception the species of *Brachiolejeunea* are found on trees or on rotten logs. In many cases they grow mixed with other *Lejeuneae* or with *Frullaniae* but they sometimes form extensive mats by themselves. The plants are usually more or less pigmented and often appear very dark brown or nearly black, with little or no indication of glossiness. The prostrate stems cling closely to the substratum by means of numerous rhizoids, which take their origin from rudimentary discs at the bases of the underleaves. The branching is at first irregularly pinnate, but the female plants after flowering usually exhibit a false dichotomy very much as in *Marchesinia*.

The leaves are imbricated and sometimes densely so. In dry

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plants the lobes are suberect and wrapped around the stem, but as soon as they become moistened they spread widely (PLATE 6, FIGURE 1) and assume a more or less squarrose position. The change in appearance is very similar to what is found in the genus *Mastigolejeunea*. The lobes are approximately ovate in outline and vary at the apex from rounded to apiculate or acute. The margin is usually entire, but, in certain species, tends to be slightly serrulate in the neighborhood of a female inflorescence. The lobule is relatively large and consists of two distinct portions approximately equal in size (FIGURES 1, 2). One of these occupies the carinal region and takes part in the formation of a conspicuous water-sac, usually about half as long as the lobe. The other is bounded by the free margin and is closely appressed to the lobe except at the apical sinus where an opening into the sac is to be observed. The appressed portion of the free margin bears a series of teeth from three to ten in number. These teeth vary greatly in size and in form (FIGURES 7–9), but in the majority of cases each tooth is several cells long and so strongly curved toward the lobe that it cannot be straightened out even by pressure on the cover-glass (FIGURE 12). The outermost tooth, which represents the apex of the lobule, varies from a single projecting cell to a broad and rounded projection (FIGURES 10, 11). The hyaline papilla is borne at the proximal base of this tooth but is displaced to the inner surface of the lobule, usually appearing two or three cells from the margin. Beyond the apical tooth the long and shallow sinus extends, forming a very acute angle with the outer part of the keel. The latter is more or less arched near the base but tends to be incurved where it meets the postical margin of the lobe. The leaf-cells have thin walls but distinct trigones (FIGURE 6). These are usually triangular in outline, two of the sides being convex and one concave. The thin places between the trigones are relatively wide and rarely develop intermediate thickenings.

The undivided underleaves are rotund to reniform in outline and are attached by an arched line (FIGURE 1). In certain species they are distinctly auriculate at the base (FIGURE 14); in others they are rounded or even cuneate. The margins are sometimes plane and sometimes more or less revolute; they vary from entire to irregularly sinuate but are never distinctly toothed.

In the majority of the species two types of branching are to be observed, very much as in the genus *Bryopteris* and in certain other genera of the *Lejeuneae Holostipae*.* In at least one species, however, all of the branches seem to conform to the *Lejeunea* type, being borne behind leaves with lobules. The *Frullania* type of branching, in which the subtending leaves fail to develop lobules, is largely restricted to robust vegetative axes. In a branch of this character the subtending leaf is partly inserted on the main axis and partly on the branch, the postical base being slightly revolute (FIGURES 2, 13). The first underleaf is usually distinctly bilobed and is displaced in such a way that the branch seems to arise from its axil. It embraces the base of the branch and partially enwraps the postical base of the subtending leaf. The first leaf is of small size and complicate-bilobed, but the lobule is explanate and rounded at the apex. The succeeding leaves and underleaves are normal in appearance. The *Lejeunea* type of branching, even where it does not occur in the vegetative portion of a plant, is almost invariably associated with subfloral innovations. An exception to this condition, however, is found in the remarkable *B. sandvicensis* (Gottsche) Evans, of eastern Asia and the Hawaiian Islands.† In this species the bract behind which a subfloral innovation arises is wholly destitute of a lobule and is partially inserted on the innovation itself.

The inflorescence in *Brachiolejeunea* seems to be fairly constant for a given species and may be dioicous, autoicous, or paroicous. The female branch varies greatly in length but is usually distinctly elongated. Subfloral innovations are invariably present and usually occur in pairs (FIGURES 4, 5); in rarer cases only one innovation is developed. The innovations are often floriferous and give rise to the false dichotomy which is characteristic of the genus. The bracts are scarcely complicate and the lobe is usually more pointed than in the leaves. In many species a wing is developed at the base of the keel (FIGURES 4, 5). The bracteole is free or nearly so and varies at the apex from rounded to retuse or shortly bilobed. The perianth scarcely projects beyond the bracts unless the basal portion elongates with the development of the sporophyte. It is

* See Evans, Bull. Torrey Club **34**: 559. 1908.

† Trans. Conn. Acad. **10**: 419. 1900.

approximately obovoid in shape and rounded to truncate at the apex, with a short beak. It is sometimes terete and sometimes more or less compressed, but even in the latter case the lateral keels are never sharp. The postical surface bears from two to five keels, and the antical surface is either plane or provided with three or four keels (FIGURES 21, 22). All of the keels are rounded and are never winged or toothed in any way. In pluriplicate perianths they are separated from one another by deep grooves, and there is no difference, except in position, between the lateral keels and the others.

In autoicous and dioicous species the male spikes are long and often proliferate at the apex. The bracts are imbricated and tend to be smaller than ordinary leaves, but their lobules are relatively larger and more strongly inflated. Even here the free margin of the lobule is usually more or less toothed. The antheridia occur in pairs, and the bracteoles are found throughout the entire length of the spike. In paroicous species the bracts are much fewer and are essentially like normal leaves; they differ also from the bracts just described in bearing the antheridia singly.

The present genus is in most respects clearly defined. The squarrose leaves, the large lobules with teeth along the free margin, the subfloral innovations usually occurring in pairs, and the plicate perianth with unarmed keels afford an excellent combination of generic characters. Certain species, however, as Spruce has already pointed out, show a relationship with *Marchesinia*, while others are even more closely allied to the genus *Ptychocoleus* as restricted in the present paper. In most species of *Marchesinia* the free margin of the lobule is also denticulate and the subfloral innovations occur in pairs, but the leaves are not squarrose and their lobes are relatively smaller and very different in appearance from those found in *Brachiolejeunea*. The perianth, moreover, is distinctly compressed and plane on both antical and postical surfaces. The characters which separate *Brachiolejeunea* from *Ptychocoleus* will be considered under the latter genus.

Two species of *Brachiolejeunea*, **B. densifolia** (Raddi) comb. nov.* and *B. corticalis* (Lehm. & Lindenb.) Schiffn., have been re-

*This species is commonly known as *B. bicolor* (Nees) Schiffn., in spite of the fact that *Frullanoides densifolia* Raddi and *Jungermannia bicolor* Nees have long been considered synonyms. Trevisan restored Raddi's specific name, but has not been fol-

ported from the West Indies. Neither of these has yet been found in Puerto Rico, but a third species occurs in recent collections from the island. It is apparently undescribed and may be characterized as follows:

Brachiolejeunea insularis sp. nov.

Dull-yellowish or brownish-green, sometimes almost black, scattered or growing in depressed mats: stems 0.25 mm. in diameter, sparingly pinnate, the branches obliquely to widely spreading, similar to the stem but with somewhat smaller leaves, never microphyllous: leaves closely imbricated, the lobes slightly falcate, ovate, 1.2–1.7 mm. long, 0.85–1.2 mm. wide, rounded to subcordate at the base and rounded or very obtuse at the apex, margin entire, strongly outwardly curved from the antical base to the apex; lobule ovate-triangular in outline, 0.85–1 mm. long, 0.35–0.45 mm. wide, the inflated portion forming a conical water-sac about half as long as the lobe, keel nearly straight from a more or less arched base, usually forming a continuous line with the postical margin of lobe, free margin rounded to cordate at the base, usually bearing from eight to ten more or less distinct teeth, those normally developed two or three cells long, one or two cells wide at the base and curved inward toward the lobe, apical tooth very variable; cells of lobe more or less convex, averaging 14 μ at the margin, 28 × 22 μ in the middle and 35 × 28 μ at the base, intermediate thickenings infrequent, oval: underleaves loosely imbricated, plane, broadly orbicular, 0.6–0.7 mm. long, 0.75–0.85 mm. wide, distinctly auriculate at the base with crenulate auricles, margin otherwise entire or irregularly sinuate, apex broad, truncate to retuse: inflorescence paroicous: ♀ inflorescence borne on a long branch and innovating on both sides; bracts erect-spreading, indistinctly complicate and unequally bifid, the lobe ovate to oblong, 1.4 mm. long, 0.85 mm. wide, rounded to obtusely pointed at the apex, margin more or less sinuate and crispate but not toothed, lobule adnate to lobe for greater part of its length, ovate to oblong, 0.85 mm. long, 0.35 mm. wide, apex mostly acute, rarely blunt, margin mostly entire but rarely with a tooth near the apex, wing broad, approximately semicircular, entire, usually adnate for its whole length; bracteole

lowed by subsequent authors. The synonymy of the species is as follows: *Frullanoides densifolia* Raddi, Mem. Soc. Ital. Modena Fis. **19**: 38. 1823; **20**: *pl. 2. f. 5.* 1829. *Jungermannia bicolor* Nees, in Martius, Fl. Bras. 1^1: 349. 1833. *Lejeunea bicolor* Nees, in Montagne, Flor. Boliv. 66; d'Orbigny, Voy. dans l'Amér. Merid. 7^2. 1839. *Phragmicoma bicolor* Nees, in G. L. & N. Syn. Hep. 294. 1845. *Ptychocoleus densifolius* Trevis. Mem. Ist. Lomb. III. **4**: 405. 1877. *Lejeunea* (*Brachiolejeunea*) *bicolor* Spruce, Hep. Amaz. et. And. 131. 1884. *Brachiolejeunea bicolor* Schiffn. in Engler & Prantl, Nat. Pflanzenfam. 1^3: 128. 1895.

oblong to obovate, 1.2 mm. long, 0.85 mm. wide, plane or nearly so, margin entire or irregularly sinuate, apex broad, truncate or subretuse; perianth slightly exserted beyond the bracts, oblong-obovoid, 1.5 mm. long, 0.85 mm. wide, rounded to truncate at the apex, slightly or not at all compressed, mostly ten-keeled, the keels extending to below the middle, rounded and separated by deep grooves: ♂ bracts in one or two pairs below the involucre, essentially like the ordinary leaves: mature sporophyte not seen. (PLATE 6.)

On trees and logs. Near Mayagüez, *Heller* (*4463a*). Near Cayey, *Evans* (*97*). Mount Morales, Utuado, *Howe* (*465*). The writer's specimens from near Cayey may be designated the type. The species has also been collected in Cuba, *Wright, Underwood & Earle*, and in Jamaica, *Underwood, Evans.*

B. insularis is closely related to *B. densifolia*, and the two species have been more or less confused. *B. densifolia* was originally collected in Brazil, where it seems to be abundant and widely distributed. Its range extends also along the chain of the Andes from Colombia to Bolivia. In North America it has been recorded from Mexico by Gottsche and from the island of St. Vincent by Spruce. It resembles *B. insularis* in general habit, in its auriculate underleaves and in its pluriplicate perianth. It is markedly distinct, however, in its dioicous inflorescence, the male inflorescences forming long spikes with closely crowded bracts. It differs also in its greater size, in its more sharply pointed leaves, in the fewer and smaller teeth along the free margin of the lobule and in its revolute underleaves. Even in *B. densifolia* the leaves are sometimes rounded as in *B. insularis*, but this is an exceptional condition and is usually associated with incomplete development.

B. corticalis, which is surely to be expected in Puerto Rico, is considerably smaller than *B. insularis*, and the teeth along the free margins of the lobules are fewer and simpler, each tooth consisting usually of a single projecting cell. The species is further characterized by its dioicous inflorescence, by the more distinct bracteal lobules, ligulate-lanceolate in outline and rounded at the apex, and by the more strongly compressed perianth with fewer and more irregular keels. Another close ally is *B. chinantlana* (Gottsche) Schiffn.,* at present known from Mexico and Ecuador.

* Hedwigia **33**: 180. *pl. 9. f. 32–40.* 1894. The species is based on *Phragmicoma bicolor* var. *chinantlana* Gottsche, Mex. Leverm. 172. 1863.

This species agrees with *B. insularis* in its inflorescence, but the lobes of its leaves and bracts are sharply pointed. The bracteole is also said to be emarginate or even bifid, but the figure of Schiffner does not show this condition clearly.

PTYCHOCOLEUS

The history of Trevisan's genus *Ptychocoleus* has already been noted by the writer in another connection.* It is based on *Phragmicoma*, § *Ptychanthoides* of the Synopsis Hepaticarum, and most of its species would be included in the genera *Acrolejeunea*, *Brachiolejeunea* or *Mastigolejeunea*, as these are at present understood. The first species listed by Trevisan is *P. aulacophorus* (Mont.) Trevis. This was originally described by Montagne,† under the name *Phragmicoma aulacophora*, from specimens collected in the Mangareva or Gambier Islands, of Spencer Gulf, South Australia, but is now known to have a wide range extending into both Asia and Africa. *Ptychocoleus aulacophorus* would naturally be selected as the type of the genus. This species, however, is placed by Stephani in *Acrolejeunea*, and it therefore seems justifiable, in restoring the name *Ptychocoleus*, to apply it to the genus *Acrolejeunea* as defined by Spruce and by Schiffner.

In this restricted sense *Ptychocoleus* would include between forty and fifty recognized species, all of which are tropical in their distribution. It attains its best development in southeastern Asia and the islands of the Pacific but is also well represented in Africa. In America five species are at present known, three of which have been reported from the West Indies. Only one species, however, *P. polycarpus* (Nees) Trevis., has been collected in Puerto Rico. As in the preceding genus, practically all the species of *Ptychocoleus* grow on trees or on rotten logs.

The genus is characterized by an elongated female branch without innovations and by a plicate perianth with smooth keels (PLATE 7, FIGURE 2), the number varying from four to ten in different species. The absence of subfloral innovations will at once distinguish it from *Brachiolejeunea*, but the two genera agree so

* Bull. Torrey Club 34 : 543. 1908.

† Ann. Sci. Nat. Bot. II. 19 : 259. 1843. Voy. au Pôle Sud, Bot. 1 : 210. *pl. 19. f. 1.* 1845.

closely in the characters derived from the lobes of the leaves, from the underleaves, and from the bracts and perianths that it would be superfluous to describe these organs in detail for *Ptychocoleus*. There are also no essential differences in color, in general habit, or in cell-structure. The lobules of the leaves, however, are much more variable in *Ptychocoleus* than in *Brachiolejeunea*, especially with respect to the number of teeth on the free margin. Certain species develop as many as four or five teeth, others only two (FIGURE 5), while in still others the margin is quite entire except for the apical tooth. In the position of the hyaline papilla the genus agrees with *Brachiolejeunea*, except for the fact that it is sometimes so much displaced that it is difficult to determine whether it is distal or proximal to the apical tooth, while on the other hand it may arise directly from a marginal cell. The position, however, is usually constant for a given species. The branching, so far as observed, always conforms to the *Lejeunea* type.

The genus shows but little relationship with other *Lejeuneae* which lack subfloral innovations. In *Lopholejeunea* the keels of the perianth are winged and variously toothed or laciniate, the lobules are built up on a different plan, and the local thickenings in the cell-walls are different. In *Caudalejeunea* the perianth is trigonous, its keels are normally winged and toothed, the plants are different in habit, and the leaf-cells show very numerous intermediate thickenings. In *Bryopteris* the female branch is much shorter, the perianth is again trigonous, the leaves and underleaves are sharply toothed, and the whole habit, general appearance, and cell-structure are different.

PTYCHOCOLEUS POLYCARPUS (Nees) Trevis.

Jungermannia polycarpa Nees, in Martius, Fl. Bras. **1**[1]: 350. 1833.

Phragmicoma polycarpa Nees, in G. L. & N. Syn. Hep. 295. 1845.

Lejeunea domingensis Tayl. Lond. Jour. Bot. **5**: 389. 1846.

Ptychocoleus polycarpus Trevis. Mem. Ist. Lomb. III. **4**: 405. 1877.

Lejeunea (*Acro-Lejeunea*) *domingensis* and *polycarpa* Spruce, Hep. Amaz. et And. 116. 1884.

Acrolejeunea polycarpa Schiffn. in Engler & Prantl, Nat. Pflanzenfam. **1**[3]: 128. 1895.

Olive-green, not glossy, scattered or growing in depressed mats: stems 0.17 mm. in diameter, irregularly pinnate, the branches widely spreading, occasionally microphyllous: leaves densely imbricated, the lobe suberect and convolute when dry, widely spreading and squarrose when moist, more or less convex, broadly ovate, slightly falcate, 1–1.2 mm. long, 0.85–0.95 mm. wide, arching partially or wholly across axis, rounded at base, rounded to very obtuse at the apex, margin entire, strongly outwardly curved from the antical base to the apex; lobule ovate, 0.6 mm. long, 0.35 mm. wide, the inflated portion occupying a little more than the carinal half, keel arched, forming an obtuse or rounded angle with the postical margin of lobe, free margin straight or a little curved, often bearing a tooth one or two cells long in the vicinity of the apical tooth, the latter mostly two cells long and one and two cells wide at the base, slightly outwardly curved, hyaline papilla borne on a marginal cell but slightly displaced to the inner surface of the lobule; cells of lobe plane or nearly so, averaging 15 μ at the margin, 23 × 18 μ in the middle and 35 × 18 μ at the base, intermediate thickenings occasional, oval or circular: underleaves loosely imbricated, plane or slightly revolute at the apex, broadly orbicular-obovate, 0.6 mm. long, 0.75 mm. wide, cuneate toward base and attached by an arched line, broad and truncate at the apex, margin entire or vaguely angular-denticulate: inflorescence autoicous or polyoicous: ♀ inflorescence borne on an ascending and more or less elongated branch; bracts widely spreading, complicate with a rounded keel and shortly and unequally bifid, the lobe ovate, 1.6 mm long, 0.85 mm. wide, acute and apiculate, the apex usually tipped with a row of two or three cells, margin entire, lobule acuminate, otherwise similar to the lobe, 1.4 mm. long, 0.4 mm. wide; bracteole free, oblong or ovate, 1.4 mm. long, 0.85 mm. wide, undivided and acute or shortly bidentate at the apex with sharp or blunt teeth, margin otherwise entire; perianth about one third exserted, obovoid, 1.5 mm. long, 0.85 mm. wide, slightly compressed and cuneate toward the base, truncate to retuse at the apex, antical face plane or nearly so, postical face with two confluent rounded keels often extending beyond the beak: ♂ inflorescence terminating a more or less elongated simple branch, not proliferating; bracts mostly in eight to twelve pairs, shortly and unequally bifid with a strongly arched keel, lobe obliquely spreading, more or less squarrose, rounded, lobule suberect, mostly acute; antheridia borne singly; bracteoles extending the whole length of the spike, similar to the underleaves but more often revolute at the apex: capsule about 0.5 mm. in diameter, walls of inner layer of cells thickened on the inside with a few large circular or oval pits;

spores green, spherical or ellipsoidal, 35 μ in diameter, minutely verruculose and with circles of indistinct radiating ridges; elaters about 10 μ in diameter, sometimes bispiral in the middle. (PLATE 7, FIGURES 1–11.)

On trees. Between Cayey and Caguas, *Howe* (*1411 p. p., 1414*). Type locality, Brazil, *Martius;* since found by numerous collectors. Known also from Mexico, *Liebman*, and from the following islands of the West Indies: Cuba, *Wright;* Santo Domingo, *Persoon* (the type locality of *Lejeunea domingensis*); Jamaica, *Harris, Evans.*

The species is not well described in the Synopsis Hepaticarum, but some of its most significant characters have since been emphasized by Schiffner.* Considerable confusion was introduced by Taylor into the synonymy of the plant by the publication of *Lejeunea domingensis.* This species was based on specimens which he at first called *L. linguaefolia*, and material thus named was deposited in the Hooker herbarium. Subsequently he renamed the species *L. domingensis* and transferred the name *L. linguaefolia* to an entirely distinct plant collected by Richard on the island of St. Thomas. Both species were soon afterwards published in the same paper. Many years later, Spruce, basing his opinion on the specimens in the Hooker herbarium rather than on Taylor's descriptions, referred both *L. domingensis* and *L. linguaefolia* to his subgenus *Acro-Lejeunea*, apparently considering them distinct from each other and also from *Ptychocoleus polycarpus.* Through the study of authentic material in the Lindenberg herbarium, Stephani † was able to reduce both species to synonymy, *L. domingensis* proving to be identical with *Ptychocoleus polycarpus* and the true *L. linguaefolia* from St. Thomas proving to be the same as *Brachiolejeunea corticalis.* Specimens in the Mitten herbarium, now in the possession of the New York Botanical Garden, amply confirm the conclusions of Stephani.

The keels of the perianth in *P. polycarpus* scarcely extend below the middle and are exceedingly variable even on a single plant. According to Schiffner, five or six keels are present, while Spruce gives the number as four or five. These discrepancies are

*Hedwigia **33**: 181. 1894. See also Gottsche, Abhandl. naturw. Verein. Bremen **7**: 350, 351. 1882.

†Hedwigia **28**: 166, 167. 1889; **29**: 22. 1890.

doubtless due to differences of interpretation. When the antical surface is deeply grooved it produces the effect of two rounded keels, making the total number five or six, according to whether the confluent postical keels are counted as one or two. When the antical face is plane the number of keels would naturally be estimated as four.

The two other species of *Ptychocoleus* which have been reported from the West Indies are *P. torulosus* (Lehm. & Lindenb.) Trevis. and *Lejeunea* (*Acrolejeunea*) *atroviridis* Spruce,* both of which are listed by Spruce from the island of St. Vincent, where they were collected by Elliott. The second of these species is known from no other locality, but *P. torulosus* is known also from Guiana and Brazil. In *L. atroviridis* the trigones of the leaves are absent or minute and the keels of the perianth are more or less roughened, so that it is possible that it ought to be referred to some other genus. *P. torulosus*, however, is a typical representative of *Ptychocoleus*. It may be at once distinguished from *P. polycarpus* by the blunt lobes and lobules of its bracts, by its truncate bracteole and by its seven- to nine-keeled perianth. It is distinct also in the lobules of its leaves, which bear from three to eight teeth along the free margin instead of one or two.

ARCHILEJEUNEA

According to Schiffner, the genus *Archilejeunea* contained thirty species in 1895, and perhaps a dozen new species have been proposed since he made his estimate. If, however, *A. porelloides* (Spruce) Schiffn., the first species described by Spruce, be selected as the type of the genus, certain species have been referred to it which can hardly be considered congeneric with this type species. This is the case, for example, with *A. pseudocucullata* Steph. (*Lejeunea holostipa* Spruce), which the writer has already made the type of the genus *Cyrtolejeunea*.† It is true of *A. xanthocarpa* (Lehm. & Lindenb.) Steph. and its immediate allies, for the reception of which the genus *Leucolejeunea* Evans has recently been proposed. It is also true of *A. conferta* (Meissn.) Schiffn., which belongs to the genus *Anoplolejeunea* and is even synonymous with its type species.

* Jour. Linn. Soc. Bot. **30**: 335. *pl. 20. f. 5–10.* 1894.

† Bull. Torrey Club **30**: 552. 1903.

If these aberrant forms are removed, the species which are left will fully agree with the characters assigned to the genus by Spruce and by Schiffner. In the majority of cases the plants are robust and show a reddish or brownish pigmentation. A prostrate and irregularly branched caudex is first developed, which clings closely to the substratum (PLATE 8, FIGURE 2). From this, secondary stems soon arise which are more or less free from the substratum and rarely form rhizoids; they branch irregularly, many of the branches being subfloral innovations (FIGURE 1). Although the branches frequently bear smaller leaves than the stem, they are never truly microphyllous.

The leaves are imbricated but not densely so, and the lobes spread obliquely or widely from the axis, being more or less falcate. They vary in outline from suborbicular to ligulate, the apices are rounded and the margins are entire. The lobules, in their most typical form, are rhomboidal in outline, the keel being straight or nearly so. In some cases about half of the lobule is appressed to the lobe, restricting the water-sac to a narrow linear space along the keel. In other cases the appressed portion is much narrower (FIGURE 2) and may even be absent altogether, the free margin meeting the lobe at a right angle. Under these circumstances the water-sac is relatively larger and the entire lobule may enter into its formation. The free margin is more or less curved and terminates in an apical tooth, which varies from subacute to long-acuminate; the sinus beyond is long but usually shallow. The hyaline papilla is at the proximal base of the apical tooth and may be either marginal or slightly displaced to the inner surface of the lobule. Except for the apical tooth the margin is commonly entire. In certain species, however, a second tooth is sometimes developed, proximal in position to the papilla (FIGURE 4). In some cases the secondary stems fail to develop normal lobules (FIGURE 1), and it becomes necessary to search for them on the prostrate caudex. The cells of the lobe have firm and pigmented walls and are usually a little convex. The trigones are large and conspicuous, and intermediate thickenings are frequent. The trigones are sometimes triangular but it is more usual for them to be triradiate with rounded rays (FIGURE 3).

The underleaves vary from orbicular to reniform. They are

broad and rounded at the apex, entire along the margin, and variable at the base, being sometimes cuneate and sometimes rounded or subcordate. The line of insertion is slightly arched and there is sometimes a rudimentary radicelliferous disc at the base. Except on the caudex, however, rhizoids are very scantily developed.

In the majority of cases the inflorescence is dioicous, but a few autoicous species have been described. The female inflorescence is borne on a secondary stem or one of its leading branches and usually innovates on only one side. In a few species, however, two subfloral innovations are occasionally developed. An innovation spreads obliquely and frequently forms a second archegonium after bearing only one or two pairs of foliage leaves. When this procedure is repeated several times in succession, a cymose flower-cluster is the result, in which the flowers seem to be borne along the upper side of a floral axis. In rare cases an innovation is terminated by an antheridial spike. The bracts are unequally bifid and sharply complicate but are apparently never winged along the keel. The lobes spread obliquely and are relatively narrower than in the leaves, often showing a tendency to be sharp-pointed at the apex. The lobule is also narrow and varies at the apex from rounded to acute. The bracteole is free and ovate to obovate in outline, the apex showing all variations in different species from rounded or retuse to bidentate or bifid. In both bracts and bracteoles the margins are commonly entire. The perianth is oblong to obovate in outline, with a rounded or truncate apex and a short beak. It is more or less compressed with sharp lateral keels (FIGURE 8). The antical surface commonly bears a short and low keel in the upper part, while the postical surface bears two sharp and confluent keels extending to below the middle. Both lateral and postical keels usually develop narrow and interrupted wings which are either irregularly sinuous or angular-dentate along the margin. In other respects the surface of the perianth is smooth.

The male inflorescence is large and conspicuous, terminating a secondary stem or one of its leading branches; in many cases, however, it proliferates at the apex. The diandrous bracts are loosely imbricated and unequally bifid, both lobe and lobule being either

rounded or very obtuse at the apex. The bracteoles extend the whole length of the spike and are much like the underleaves.

Several genera of the *Lejeuneae Holostipae* are more or less closely allied to *Archilejeunea*. Certain species of *Brachiolejeunea* and *Ptychocoleus*, for example, develop a five-keeled perianth which is built up on a very similar plan. In *Brachiolejeunea*, however, the lobule is differently constructed and shows a larger number of marginal teeth, while in *Ptychocoleus* no subfloral innovations are present. Both of these genera, moreover, are composed of prostrate species which show no distinction between caudex and secondary stems, and which are further characterized by the smooth and wingless keels of their perianths. In *Mastigolejeunea* the distinction between caudex and secondary stems is well marked but the perianth is sharply trigonous with smooth keels. Spruce divided his subgenus *Archi-Lejeunea* into two sections: *Monotropella*, in which the keels of the perianth are rough and the subfloral innovations usually occur singly; and *Dibrachiella*, in which the keels are smooth and the innovations are sometimes borne in pairs. Schiffner accepts both of these sections, making them subgenera of his genus *Archilejeunea*. Whether the slight differences just noted will ever be deemed sufficient to separate the groups generically is doubtful, since they share so many characters in common. It must be admitted, however, that *Dibrachiella* shows an especially close relationship to *Brachiolejeunea* and *Ptychocoleus*.

In its restricted sense *Archilejeunea* is almost exclusively tropical in its distribution. A number of species have been described from Africa and from the islands of the Pacific, but the highest development of the genus is attained in South America, where about half of the known representatives have been collected. At the present time no species are definitely known from Asia and only two species, both belonging to the subgenus *Dibrachiella*, have been reported from the West Indies. One of these is *A. Auberiana* (Mont.) Steph., originally described from Cuba, and the other is *A. Cruegeri* (Lindenb.) Schiffn., originally described from Trinidad. The distribution of these two species beyond the islands where they were first discovered is still imperfectly known. Stephani, to be sure, has reported *A. Auberiana* from Paramaribo

and Para,* and Spruce has also reported *A. Cruegeri* from the latter locality.† Stephani's report is based on two specimens in the Lindenberg herbarium, one doubtfully referred to *Lejeunea unciloba* Lindenb. and the other representing a portion of the original material of *L. cyclostipa* Tayl. The writer has examined both of these specimens and would refer the first to *L.* (*Archi-Lejeunea*) *florentissima* Spruce rather than to *A. Auberiana*;‡ the second is unfortunately so fragmentary that positive determination is hardly possible. With regard to *A. Cruegeri* the type material itself is scanty and poorly developed, making it difficult to obtain an adequate idea of the species. In view of these facts confirmatory evidence as to the occurrence of *A. Auberiana* and *A. Cruegeri* in South America is much to be desired. Although *Archilejeunea* has not yet been reported from Puerto Rico, a single species, also belonging to the subgenus *Dibrachiella*, has been found on the island, namely:

Archilejeunea viridissima (Lindenb.)

Lejeunea viridissima Lindenb. in G. L. & N. Syn. Hep. 320. 1845.

Lejeunea (*Archi-Lejeunea*) *viridissima* Steph. Hedwigia **29**: 17. 1890.

Yellowish- or brownish-green, becoming darker with age, neither glossy nor glaucous, growing in depressed mats: caudex and secondary stems about 0.14 mm. in diameter, the latter simple or sparingly subdivided, often with poorly developed lobules: leaves imbricated, the lobe widely spreading, slightly falcate, broadly ovate, 0.75 mm. long, 0.6 mm. wide, convex, and sometimes revolute at the broad and rounded apex and along the postical margin, antical margin straight or a little rounded at the base, then strongly outwardly curved to the apex; lobule (when well developed) ovate, 0.35 mm. long, 0.25 mm. wide, the water-sac broad at the base and abruptly narrowed in the outer part, free margin sometimes revolute at the base, sometimes appressed to the lobe from base to apex, rounded, normally bearing two teeth in the outer part, the outer or apical a little longer than the other and often variously curved, the inner varying from acute to obtuse and sometimes

* Hedwigia **29**: 15, 21. 1890.

† Hep. Amaz. et And. 97. 1884.

‡ See Torreya **7**: 228. 1908.

absent altogether, papilla marginal at base of apical tooth, sinus shallow, keel slightly arched, forming a very obtuse angle with the postical margin of the lobe; cells of lobe plane or a little convex, averaging 12 μ at the margin, 24 × 18 μ in the middle and 28 × 18 μ at the base, trigones large, triradiate with rounded ends, separated from the oblong to circular intermediate thickenings by narrow pits: underleaves distant to loosely imbricated, appressed on the caudex but more or less squarrose on the secondary stems and sometimes revolute at the apex and along the sides, broadly orbicular-obovate, averaging 0.35 mm. in length and 0.4 mm. in width, cuneate at the base, rounded to subretuse at the apex: inflorescence polyoicous: ♀ inflorescence terminating a secondary stem or one of its leading branches, innovating on one side or rarely on both, the innovations short and sterile or soon again floriferous, rarely terminating in an antheridial spike; bracts erect-spreading, deeply and unequally bifid, complicate, the lobe oblong-obovate, 0.95 mm. long, 0.5 mm. wide, more or less convex and often revolute along the postical margin and at the apex, lobule ovate to ligulate, 0.4 mm. long, 0.15 mm. wide, rounded to subacute at the apex, keel very short; bracteole obovate, averaging 0.75 × 0.4 mm., rounded to retuse at the apex; perianth about half exserted, oblong-obovate in outline, cuneate toward the base, 1.4 mm. long, 0.75 mm. wide, antical keel low and broad, lateral and postical keels high and sharp, usually bearing narrow wings from one to three cells wide and variously sinuate or subcrenulate on the margin: ♂ inflorescence terminating a short branch, apparently not proliferating; bracts loosely imbricated, mostly in from three to six pairs, unequally bifid, the lobe oblong to rounded at the apex, lobule similar but shorter and narrower, keel strongly arched; antheridia in pairs; bracteoles similar to the underleaves but smaller: capsule about 0.4 mm. in diameter, yellowish-brown; spores greenish, irregular in form, about 16 μ in short diameter, minutely verruculose; elaters 9 μ in diameter. (PLATE 8, FIGURES 1–8.)

On a log. El Yunque, *Evans* (*140*). Type locality: Caracas, Venezuela (herb. Hampe). The species has also been found on the island of Great Bahama, *Britton & Millspaugh*. The type material preserved in the Lindenberg herbarium agrees closely with the Puerto Rico and Bahamian specimens.

Archilejeunea viridissima is closely related to *A. Auberiana*. Through the kindness of M. Paul Hariot the writer has been supplied with a portion of the original material of the latter species from the Montagne herbarium. It shows an autoicous inflorescence and agrees with *A. viridissima* in size, habit, and color.

The lobules in both species are normally bidentate, and the perianths are five-carinate with smooth or nearly smooth keels. The lobule in *A. Auberiana*, however, is subrectangular in outline rather than ovate, the keel being nearly straight, and the marginal teeth tend to be larger and more pronounced than in *A. viridissima*. The leaf-cells also offer certain points of distinction, although they average about the same in size. In *A. Auberiana* the local thickenings of the walls are rarely confluent, the trigones are mostly in the form of equilateral triangles with straight sides, and the intermediate thickenings are oval or circular in outline. In *A. viridissima*, on the other hand, the thickenings are more frequently confluent, the trigones show a strong tendency to be triradiate, with rounded and often constricted rays, and the intermediate thickenings show a similar tendency to be rectangular, with rounded ends. *A. Auberiana* is further characterized by the lobules of its perichaetial bracts; these are much smaller than in *A. viridissima* and are usually adnate to the lobes throughout their entire length. Although the differences which have just been enumerated are slight, they seem to be constant.

Another allied species is *Lejeunea florentissima* Spruce, which the writer would keep distinct from *A. Auberiana*. This species is more robust than *A. viridissima*, and the lobes of the leaves are more falcate; the keel of the lobule is parallel with the free margin, but both are more or less curved; the trigones in the leaf-cells are similar to those in *A. Auberiana* but are better developed, the sides of the triangles being convex rather than straight. The subfloral innovations in *L. florentissima* are usually soon floriferous and the perianths are thus crowded together in a cymose cluster; in *A. viridissima* the arrangement of the perianths is much more irregular.

LEUCOLEJEUNEA

The characters of the genus *Leucolejeunea*, recently segregated by the writer from *Archilejeunea*, have already been so fully discussed * that it hardly seems necessary to enumerate them here. Five species are definitely known at the present time, the generic type being *L. clypeata* (Schwein.) Evans, a widely distributed species in the eastern United States. The only representative of

* See Torreya 7: 225–229. 1908.

the genus which has been found in Puerto Rico is *L. xanthocarpa*, although *L. unciloba* (Lindenb.) Evans is surely to be expected on the island.

LEUCOLEJEUNEA XANTHOCARPA (Lehm. & Lindenb.) Evans

Jungermannia xanthocarpa Lehm. & Lindenb. in Lehmann, Pug. Plant. **5**: 8. 1832.

Lejeunea xanthocarpa Lehm. & Lindenb.; G. L. & N. Syn. Hep. 330. 1845.

Lejeunea (*Archi-Lejeunea*) *xanthocarpa* Pears. Christiana Vidensk.-Selsk. Forh. **1887**[9]: 4. *pl. 1. f. 14–24.*

Archilejeunea xanthocarpa Schiffn. Conspect. Hepat. Archip. Indici 316. 1898.

Leucolejeunea xanthocarpa Evans, Torreya **7**: 229. 1908.

Pale glaucous-green, varying to bright-green and becoming yellowish or brownish upon drying, growing in depressed mats: stems 0.15 mm. in diameter, the branches obliquely to widely spreading, with smaller leaves than the stem but not microphyllous, sterile branches mostly simple or sparingly subdivided: leaves imbricated and usually densely so, the lobe (when flattened out) orbicular-ovate, 1 mm. long, 0.85 mm. wide, convex and strongly revolute at the broad and rounded apex and along the whole postical margin, antical margin straight or slightly rounded at base, then outwardly curved to the apex; lobule narrowly ovoid, 0.4 mm. long, 0.2 mm. wide, gradually contracted in the outer half, the water-sac opening directly into the revolute portion of the lobe, keel straight or slightly arched continuous with revolute portion or slightly indented at junction, apex (not visible without flattening or dissection) varying from bluntly pointed to acuminate, in the latter case tipped with a row of from two to four cells, sinus straight or slightly lunulate, hyaline papilla mostly three to six cells from the apex; cells of lobe plane or slightly convex, averaging 14 μ at the margin, 20 μ in the middle, and 28 × 20 μ at the base: underleaves imbricated, plane (or a little convex from below), reniform, 0.5 mm. long, 0.7 mm. wide, rounded to cordate at the base, rounded to vaguely retuse at the apex: ♀ inflorescence borne on a more or less abbreviated branch, sometimes with only one pair of leaves below the involucre, innovating on one side; bracts erect-spreading, the lobe falcate, convex, revolute at the rounded apex and along the postical margin, oblong-obovate, 1 mm. long, 0.6 mm. wide, lobule oblong, 0.4 mm. long, 0.2 mm. wide, rounded to subacute at the apex, keel sometimes narrowly winged; bracteole broadly obovate, 0.95 mm. long, 0.75 mm. wide, slightly

retuse at the apex; perianth almost hidden by the involucre, 1 mm. long, 0.7 mm. wide, narrowed toward the base, rounded to slightly retuse at the apex, beak 0.1–0.15 mm. long, keel roughened by projecting cells but destitute of wings or distinct teeth: ♂ inflorescence as described under the genus. (PLATE 7, FIGURES 12–23.)

On trees. Near Cayey, *Evans* (76). The species is also known from the following islands of the West Indies: New Providence, Bahamas, *A. E. Wight, E. G. Britton;* Jamaica, *Underwood, Evans;* Guadeloupe, *Husnot, Duss;* Dominica, *Elliott;* Martinique, *Duss.* On the American continent its range extends from Mexico to Brazil (the type locality). There are also records from Java and from Fernando Po, Mount Kilimanjaro and Cape Colony in Africa. A fragment of the type specimen in the Lindenberg herbarium, collected by Beyrich in 1823 at New Freiburg, Brazil, agrees closely with the specimens here described.

Apparently the closest allies of *L. xanthocarpa* are *L. unciloba*, which has already been mentioned, and *L. conchifolia* Evans.* Both of these species have convex lobes and long teeth at the apices of the lobules. In *L. unciloba*, however, the apex of the lobe is only slightly revolute, and the apical tooth of the lobule is easily visible without dissection. In *L. conchifolia* the plants are less robust than in *L. xanthocarpa*, the lobes of the leaves spread more obliquely, the lobules are relatively larger, and their apical teeth are more like those of *L. unciloba*, being readily demonstrated without dissection. *L. xanthocarpa* also bears a strong superficial resemblance to *Pycnolejeunea Schwaneckei* (Steph.) Schiffn., which is of course at once distinguished by its bifid underleaves.

ANOPLOLEJEUNEA

The genus *Anoplolejeunea*, as defined by Schiffner, contains the single species *A. herpestica* (Spruce) Schiffn. Apparently nothing has been written about this species except the rather brief descriptions of Spruce and Schiffner. The writer finds, however, upon examining a portion of the type material of *A. herpestica*, kindly

* For descriptions and figures of these two species see Evans, Mem. Torrey Club 8: 125–129. *pl. 16. f. 12–20; pl. 17. f. 1–9.* 1902. *L. unciloba* is there called *Archilejeunea Sellowiana* Steph., a species which the writer now considers synonymous with the much older *Lejeunea unciloba* Lindenb. See also Torreya 7: 229. 1908.

sent by Mr. M. B. Slater, that it is quite indistinguishable from the widely distributed *Lejeunea conferta* Meissn. Although placed by recent writers in *Archilejeunea*, *L. conferta* cannot be considered congeneric with the typical members of this genus, and there seem to be excellent reasons for maintaining *Anoplolejeunea* as distinct. Spruce compares it with his subgenus *Platy-Lejeunea*, but it is evidently much more closely related to the genus *Leucolejeunea*.

The plants grow in depressed mats and are either pale- or dark-green in color with neither glossiness nor pigmentation. The prostrate stem is copiously and irregularly branched, some of the branches being similar to the stem while others are ascending and distinctly microphyllous (PLATE 8, FIGURE 9). The normal leaves are imbricated, the convex lobe spreading widely and showing a rounded apex and entire margin. The leaf-cells are plane or nearly so, with small trigones and occasional intermediate thickenings (FIGURE 16), and ocelli are sometimes present at the base of the lobe (FIGURE 17).

The lobule when normally developed is more complicated than in most of the other genera of the *Lejeuneae*. It is ovate-oblong in outline and forms a strongly inflated water-sac with an arched and convex keel (FIGURE 9). From a relatively short base it is abruptly dilated and becomes suddenly contracted in the outer part. The dilated portion, bounded by the rounded and entire free margin, forms a volute with about one and a half turns (FIGURE 14). This comes into contact with the lobe, thus enclosing the water-sac, but the margin itself, together with a considerable extent of the lobule, lies free within the sac and can be distinguished by careful focusing from below. The lobule develops no apical tooth, the free margin being directly continuous with the sinus; just at the junction of the two, however, a cell may be observed which is a little larger than its neighbors and which doubtless represents the terminal cell of the lobule, homologous with the apical tooth of other *Lejeuneae* (FIGURE 18). At the beginning of its course the sinus is also strongly revolute but straightens out abruptly and passes into the postical margin of the lobe at the end of the keel. The hyaline papilla is marginal and arises from the terminal cell, usually at its junction with the first cell of the sinus; it may therefore be regarded as distal in posi-

tion. Unfortunately, the lobule is often poorly developed and fails to show some of the peculiarities which have just been described.

The underleaves are distant and smaller than is usual among the *Holostipae*. They are obovate and entire, the apex varying from truncate to slightly retuse. When rhizoids are developed they usually spring from a distinct basal radicelliferous disc.

The inflorescence is dioicous, and the male and female plants usually occur in separate mats. The female branch varies greatly in length and nearly always give rise to one or two subfloral innovations. In rare cases, however, the branch remains perfectly simple. The perichaetial bracts are a little larger than the leaves and their lobes are relatively narrower ; the lobules are rounded to subacute and the sharp keels are narrowly winged. The bracteole is free and mostly obovate-oblong in outline, the apex varying from rounded to slightly retuse (FIGURES 19, 21). The perianth is obovoid and normally shows five sharp keels (FIGURE 23) and a short but distinct beak. The male inflorescence occupies a short branch or is terminal on a more or less elongated branch. The bracts are imbricated and diandrous, and the bracteoles are limited to the base of the spike.

Anoplolejeunea conferta (Meissn.)

Jungermannia conferta Meissn.; Sprengel in Linnaeus, Syst. Veg. ed. 16. **4**: 325. 1827.

Lejeunea subaurita Nees & Mont. Ann. Sci. Nat. Bot. II. **5**: 60. 1836.

Lejeunea Miquelii Lehm. & Lindenb. in Lehmann, Pug. Plant. **7**: 15. 1838.

Lejeunea proteoides Lehm. & Lindenb, *l. c.* **7**: 19. 1838.

Lejeunea conferta Meissn. ; G. L. & N. Syn. Hep. 333. 1845.

Lejeunea involutiloba Mont. Ann. Sci. Nat. Bot. IV. **5**: 350. 1856.

Lejeunea (*Anoplo-Lejeunea*) *herpestica* Spruce, Hep. Amaz. et And. 129. 1884.

Lejeunea (*Platylejeunea*) *conferta* Steph. Hedwigia **27**: 284. 1888.

Lejeunea (*Archi-Lejeunea*) *conferta* Steph. *l. c.* **29**: 21. 1890.

Anoplolejeunea herpestica Schiffn. in Engler & Prantl, Nat. Pflanzenfam. 1^3: 131. 1895.

Archilejeunea conferta Schiffn. Conspect. Hepat. Archip. Indici 315. 1898.

Plants becoming yellowish or brownish upon drying: stems 0.17 mm. in diameter, branches obliquely to widely spreading: leaves imbricated, the lobe widely spreading, often revolute at the apex, falcate, broadly ovate, 1 mm. long, 0.85 mm. wide when of maximum size, often considerably smaller, arching across or a little beyond the axis, antical margin straight or slightly incurved near the base, then strongly outwardly curved to the apex, postical margin straight or somewhat curved, not revolute, forming an angle of 90 degrees or more with the strongly arched keel; lobule 0.35 mm. long, 0.2 mm. wide; cells of lobe averaging 17 μ at the margin, 25 μ in the middle and 40 × 25 μ at the base, trigones triangular with concave sides, intermediate thickenings sometimes confluent with the trigones; ocelli (when present) mostly one to three, situated near the base of the lobe, measuring about 45 × 32 μ: underleaves broadly orbicular-obovate, 0.35 mm. long, 0.35–0.4 mm. wide, plane, cuneate and short-decurrent at the base: perichaetial bracts erect-spreading, the lobe obovate from a narrow base, 1.2 mm. long, 0.7 mm. wide, convex and revolute at the apex, rounded to obtuse at the apex, lobule ovate-oblong, 0.75 mm. long, 0.25 mm. wide; bracteole 0.4–0.75 mm. long, 0.25–0.4 mm. wide; perianth about two-fifths exserted at maturity, 1–1.3 mm. long, 0.7–0.75 mm. in diameter, apex variable, usually truncate or subretuse but sometimes rounded or even subacute, keels variable, sometimes low and almost obsolete, sometimes distinctly dilated in the upper part, when well developed showing a marginal row of slightly projecting cells with strongly thickened walls, postical surface of perianth sometimes developing one or two low and supplementary keels or folds: ♂ inflorescence apparently never proliferating; bracts mostly in from two to seven pairs, closely imbricated, inflated, shortly bifid, the lobe strongly convex, rounded at the apex, antical margin straight or a little incurved, keel strongly arched, lobule obtuse to acute at the apex; bracteoles similar to the underleaves but smaller: mature sporophyte not seen. (PLATE 8, FIGURES 9–23.)

On trees. Puerto Rico, without definite locality, *Sintenis* (*100*). The writer has seen no specimens of *A. conferta* from Puerto Rico but has collected it abundantly on the island of Jamaica, where it occurs at elevations of from 1,000 to 2,000 m. The species was originally collected in Peru but is now also known from Brazil, Bolivia, Venezuela, Trinidad, Colombia, and Mexico. Whether it occurs outside of tropical America is somewhat doubt-

ful. The Synopsis Hepaticarum cites it from the islands of Luzon and Java, and Schiffner also quotes the latter locality. Both of these records, however, are based on old collections.

The microphyllous branches of *A. conferta* (FIGURE 9) are very characteristic, although they are sometimes scantily developed and may even be absent altogether. The lobes of their leaves are orbicular-ovate in outline and average about 0.35 mm. in length; they are suberect or spread obliquely from the axis instead of spreading widely as on normal stems and branches. The lobules are nearly spherical and measure only 0.15 mm. in diameter, in other respects agreeing with those on typical leaves. The underleaves, except for their small size, present no distinctive peculiarities. Under certain circumstances the lobules are poorly developed even on the stems and leading branches (FIGURE 12) and thus give rise to forms which are not always easy to recognize. Usually a careful examination will reveal a few lobules of normal structure scattered among the others, and these will aid in the determination of such anomalous specimens. The characters upon which the varieties *Miquelii* and *Liebmaniana* of the Synopsis are based are apparently drawn from imperfectly formed lobules, and the propriety of attempting to maintain them is doubtful.

In the specimens from Jamaica the lobes of the leaves are usually distinctly ocellate at the base except on poorly developed individuals. In all the South American specimens, however, which the writer has been able to examine, the ocelli are apparently absent. If this difference should prove to be constant it might necessitate the separation of the West Indian plant as a distinct species. Unfortunately the South American specimens were all of old collections, and the detection of ocelli in plants of this character is sometimes very uncertain. Under the circumstances it seems best to include the Jamaican specimens with the others, a course which is advocated also by Stephani.

A. conferta bears a rather strong superficial resemblance to *Leucolejeunea clypeata*, the two species agreeing in color and in many of the characters derived from leaf-cells, underleaves, perichaetial bracts, and perianths. They differ strikingly, however, in the structure of the lobule, and *L. clypeata* is also distinct in its inflorescence, which is normally autoicous, and in its lack of micro-

phyllous branches. There is little danger of confusing *A. conferta* with any other species of *Leucolejeunea*, in spite of the close relationship of the two genera.

The present paper concludes the discussion of the *Lejeuneae Holostipae* which are known to occur in Puerto Rico. Of the genera recognized by Schiffner the following four are apparently unrepresented on the island: *Ptychanthus*, *Thysananthus*, *Peltolejeunea* and *Dicranolejeunea*. The last of these genera is abundant on Jamaica at rather high altitudes and may therefore be expected to have a wider distribution in the West Indies. There is little probability, however, that any of the others will be found there, although each is represented in South America by one or more species. *Ptychanthus* and *Thysananthus*, in fact, are essentially paleotropic in their distribution and attain their highest development in the East Indies and the neighboring parts of Asia.

YALE UNIVERSITY.

Explanation of plates 6-8

As in the previous papers of this series the figures were drawn by the writer and prepared for publication by Miss Hyatt.

PLATE 6

Brachiolejeunea insularis Evans. Part of stem with branch, postical view, × 15. 2. Part of stem with base of branch, postical view, × 15. 3. Leaf, antical view, × 15. 4, 5. Perianths with involucres, the innovations dissected away, postical view, × 25. 6. Cells from middle of lobe, × 265. 7–9. Free margins of lobules, × 45. 10, 11. Apices of lobules, × 200. 12. Marginal teeth of lobule, × 200. 13. Stem-leaf at base of branch, × 15. 14. Basal auricle of underleaf, × 200. 15–17. Bracts and bracteole from one involucre, × 15. 18–20. Bracts and bracteole from another involucre, × 15. 21, 22. Transverse sections of perianths, × 35. Fig. 5 was drawn from specimen collected by Heller (*4463a*); Figs. 8, 9, 11, 18–20, from specimens collected by Howe (*465*); the remaining figures from the type specimen.

PLATE 7

Ptychocoleus polycarpus (Nees) Trevis. 1. Part of stem with base of a branch, postical view, × 15. 2. Apex of female branch with perianth, postical view, × 15. 3. Part of stem, antical view, × 15. 4. Cells from middle of lobe, × 265. 5. Margin of lobule, the apex on right, × 200. 6–8. Bracts and bracteole from the same involucre, × 15. 9. Subfloral leaf below involucre, × 15. 10. Bracteole from another specimen, × 15. 11. Transverse section of perianth, × 25. The figures were all drawn from specimens collected by Howe (*1411*, *1414*).

Leucolejeunea xanthocarpa (Lehm. & Lindenb.) Evans. 12. Part of sterile stem, postical view, × 15. 13. Part of plant with perianth, postical view, × 25. 14. Part of stem, antical view, × 15. 15. Leaf with lobule flattened out, × 15. 16. Cells from middle of lobe, × 265. 17. Cells from antical margin of lobe, × 200. 18, 19. Apices of lobules, × 200. 20–22. Bracts and bracteole from the same involucre, × 25. 23. Transverse section of perianth, × 35. The figures were all drawn from specimens collected by the writer (*76*).

PLATE 8

Archilejeunea viridissima (Lindenb.) Evans. 1. Apex of female stem with perianth, postical view, × 25. 2. Part of caudex, postical view, × 25. 3. Cells from middle of lobe, × 265. 4. Margin of lobule, the apex on right, × 200. 5, 6. Bract and bracteole from the same involucre, × 25. 7. Bract from another involucre, × 25. 8. Transverse section of perianth, × 25. The figures were all drawn from specimens collected by the writer (*140*).

Anoplolejeunea conferta (Meissn.) Evans. 9. Part of sterile stem with microphyllous branches, postical view, × 25. 10. Female branch with perianth, postical view, × 25. 11. Apex of male branch, postical view, × 25. 12. Branch with poorly developed lobules, postical view, × 25. 13. Lobule, postical view, × 45. 14. Longitudinal section through lobe and lobule, × 45. 15. Mouth of lobule, diagrammatic. 16. Cells from middle of lobe, × 265. 17. Cells from base of lobe, enclosing an ocellus. × 200. 18. Margin of lobule, apical end on left, × 200. 19. Perianth with involucre, postical view, × 35. 20, 21. Bract and bracteole from a single involucre, × 25. 22. Perianth, postical view, × 25. 23. Transverse section of perianth, × 35. The figures were all drawn from Jamaican specimens collected by the writer (*43*, *272*, *424*).

The ferns and flowering plants of Nantucket — II

EUGENE P. BICKNELL

GRAMINEAE

One hundred and four grasses are here enumerated and a number of varieties are indicated, some of which should perhaps bear distinctive names. Other species which flower only in the spring or early summer are doubtless to be added. In no other family of plants represented on Nantucket are introduced species more likely to appear and from this source the list should be considerably augmented as time goes on.

It is to be understood that when not otherwise stated the species referred to were found in perfect flowering or fruiting condition.

SCHIZACHYRIUM SCOPARIUM (Michx.) Nash.

Andropogon scoparius Michx.

Abundant, often the dominant grass over extensive tracts on the plains. Near Miacomet Pond a slender, thinly tufted form occurred, here and there, in which the colors were bright-green and yellowish in striking contrast to the duller green and purple of the prevailing plant. This light-colored form showed nowhere the slightest purple tinge and was palest in those parts ordinarily the most deeply colored, especially the internodes, leaf-sheaths, and spikelets.

* SCHIZACHYRIUM VILLOSISSIMUM (Kearney) Nash.

Andropogon scoparius villosissimus Kearney, U. S. Dept. Agric. Div. Agrost. Bull. **24**: 41. Ja 1901.

Common on sandy plains, roadsides, and in open pine scrub, often growing with *S. scoparium* and always readily distinguishable from it by its villous sheaths and leaf-blades. When both are fully mature, they may be distinguished at sight by a different appearance of their spikes due mainly to a somewhat denser and whiter bearding of the sterile pedicel in *S. villosissimum*.

The reference of this Nantucket grass to *S. villosissimum*, not hitherto reported from north of the Carolinas, is based on the

original description, no actual comparison having been made with type material.

* **Schizachyrium littorale** (Nash) comb. nov.

Andropogon littoralis Nash, in Britton, Man. 69. 1901.

'Sconset; Polpis. Specimens collected are less notably different from *S. scoparium* than are strongly developed examples from the Long Island and New Jersey coasts.

ANDROPOGON ABBREVIATUS Hack.

Common and widely distributed in low grounds. In some seasons not flowering until September.

ANDROPOGON VIRGINICUS L.

Common on the level tract below the "Cliff," elsewhere apparently infrequent.

ANDROPOGON FURCATUS Muhl.

Rather common in Squam, sparingly in Polpis and near Acquidness Point; not met with elsewhere.

SORGHASTRUM AVENACEUM (Michx.) Nash.

Rather common on the eastern side of the island and locally elsewhere: Abram's Point; Polpis; Squam; 'Sconset; South Pasture; the Woods; Long Pond, often only freshly in flower at the middle of September.

* PASPALUM PSAMMOPHILUM Nash. (A. S. Hitchcock, Rhodora 8: 205. 1906.)

Paspalum prostratum Nash, not Scribn. & Merr.

Common and generally distributed, often growing in pure sand. Near Gibbs' Pond plants were measured which covered a diameter of 4 to 5½ feet with their prostrate radiating stems.

PASPALUM SETACEUM Michx.

Not uncommon, but rather local: Squam; Pocomo; Quaise; near the town; Long Pond and elsewhere. Spikelets glabrous, or the convex scale ciliolate near the apex, mostly oval and 1.5 mm. long. In the usual form the larger leaves are commonly 3–6 mm. wide and the spikes 4–7 cm. long; very vigorous plants by a roadside near Long Pond had spikelets 1.75 mm. long, spikes 5–10 cm. in length, and leaves 5–13 mm. wide.

* PASPALUM MUHLENBERGII Nash.

Rather common. The usual form has the leaves 4–8 mm. wide, and rarely more than a single spike on the slender peduncle, which is sometimes thinly pilose. At Shawkemo in damp soil a few plants were met with having somewhat inflated sheaths, leaves 6–15 cm. wide, and shorter, pilose peduncles bearing twin spikes.

The Nantucket plant sometimes seems to show a close approach to *P. pubescens* Muhl.

* SYNTHERISMA FILIFORME (L.) Nash.

Common in sandy soil, especially in the neighborhood of the town, extending along roadsides to far-outlying points, as near Wauwinet and Long Pond.

SYNTHERISMA HUMIFUSUM (Pers.) Ryd.

Very common generally, often in abundance along sandy roadsides.

SYNTHERISMA SANGUINALE (L.) Dulac.

Very common.

ECHINOCHLOA CRUS-GALLI (L.) Beauv.

Common, mostly about and near the town and in the vicinity of cultivated ground. About the shores of ponds on the south side of the island occurs a form often much dwarfed and sometimes quite prostrate in the sand, having numerous reduced panicles, and spikelets like the common barnyard plant but very shortly awned.

* ECHINOCHLOA CRUS-GALLI MUTICA Vasey.

Met with several times in or near the town, rather a small form, the panicle sometimes reduced to 4–6 simple subsecund short branches bearing loosely subsecund spikelets smaller than in *E. Crus-galli* proper, with less hispid and awnless, acute or mucronate scales.

ECHINOCHLOA WALTERI (Pursh) Nash.

Occurs sparingly with *E. Crus-galli* in brackish soil about ponds on the south shore. Growing with it was a reduced form, appearing like a hybrid with *E. Crus-galli*, in which the sheaths were glabrous or the lowest minutely pubescent but not at all papillose. Not flowering until late August or September.

* PANICUM CAPILLARE L.

Uncommon, but slowly spreading. In 1899 only two plants were met with, one near the town and one at 'Sconset; in 1904 a few plants were seen in old fields on both sides of the town, one plant about three miles out on the Wauwinet road and one at 'Sconset; in 1907 single plants were noticed at several places in the town, as well as at a few outlying points.

PANICUM MILIACEUM L.

Near the town by the road to Surfside, 1899; not seen on any subsequent visit. Collected on Nantucket by Walter Deane, Sept. 9, 1885. (Hitchcock, Rhodora **3**: 100. 1901.)

PANICUM PROLIFERUM Lam.

Very common, especially so on sandy pond shores, where it often occurs in a much dwarfed condition.

PANICUM VIRGATUM L.

Very common. A reduced form was found growing in sterile soil in open pine-scrub east of Miacomet Pond: culms ascending at base, sometimes not over 4 dm. high; leaves firm and stiff, pale glaucescent-green; panicle small and contracted, the short branches appressed, sometimes 10 cm. long and only 1 cm. wide, sometimes reduced to a few sparsely flowered branches; spikelets small, 2.5–3 mm. long, the scales shorter, broader, less attenuate and less distinctly nerved than in the usual plant, the first scale relatively shorter, all the scales with less evident and more appressed tips.

Panicum anceps Michx. has been recorded from Nantucket; it would seem to be quite possible that the reduced form of *P. virgatum* described above, with its decumbent base, stiff, pale leaves, and contracted panicle, may have led to misidentification.

* PANICUM AGROSTOIDES Spreng.

Damp roadside below the "Cliff"; by a pool east of the town and in abundance by two pools north of the town; wet spot in the "Woods."

PANICUM DEPAUPERATUM Muhl.

Common; specimens collected are more or less villous with flat leaves and many basal panicles, the spikelets decidedly beaked and 3.5–4 mm. long.

* PANICUM LINEARIIFOLIUM Scribn.

Fully typical *P. lineariifolium* was not met with. The grass here referred to it, with reservations, was collected several times and is somewhat intermediate between *P. lineariifolium* and *P. depauperatum*. Nevertheless, I do not myself doubt the distinctness of these two grasses, believing that they represent a group of closely related species which will continue to be troublesome in classification until their proper lines of segregation are understood.

The Nantucket plant has much the habit and pubescence of *P. lineariifolium*, with the spikelets not larger than in that species and sometimes as pubescent, but the venation and shape of the flowering scales are more those of *P. depauperatum*, as a rule, however, wanting the pronounced beak-like termination which is so marked a feature of the latter. The spikelets are rather broadly ovoid, 2–2.5 mm. long, obtuse or subacute, the larger scales usually but not always slightly surpassing the grain.

* **Panicum Owenae** sp. nov.

Tufted, erect or ascending; culms 1.5–3.25 dm. high, slender, often geniculate at the nodes; nodes 2 or 3, bearded with a ring of appressed or ascending white hairs; lowest internodes appressed soft-pubescent, the upper ones and peduncle minutely close-puberulent; basal leaves short-lanceolate, 3–4 mm. wide, sparsely papillate-long-ciliate at base; stem-leaves 2 or 3, linear-lanceolate, ascending, 1.5–3 mm. wide, 4–10 cm. long, closely striate-nerved, minutely scabrellous-puberulent above, softly appressed-puberulent and sometimes also thinly pilose beneath and sparsely long-ciliate, attenuate, finally involute; ligule a dense fringe of hairs; sheaths striate, more or less puberulent, the lowermost often papillate-pilose; primary panicle 2–6 cm. long, puberulent, its branches ascending, the lowest usually solitary; branches of the culm slender, sometimes 6 cm. long, bearing clusters of stiff, crowded, linear, attenuate leaves and numerous spikelets; spikelets 1.5–2 mm. long, oval, occasionally orbicular or oblong, very obtuse, first scale ⅓–½ the length of the subequal second and third, strongly 1-nerved and acute to 3-nerved, sometimes obtuse, second scale 7–9-nerved, third scale 7-nerved, all minutely soft-puberulent with subappressed hairs; caryopsis white, elliptic, 1.25–1.50 mm. long.

Type collected September 20, 1907, on the sandy commons west of the town, deposited in herb. N. Y. Bot. Garden. A specimen collected September 11, 1899, is smaller and more densely

tufted, with numerous secondary branches and panicles among the crowded basal leaves. Named in compliment to Mrs. Maria L. Owen, whose name is already inseparably connected with the study of the Nantucket flora.

An interesting *Panicum*, connecting the *depauperatum* and *dichotomum* groups, and related to both *P. lineariifolium* and *P. Bicknellii*. Its relationship to the latter does not readily appear from its general aspect but becomes evident on closer study. The essential differences are the much smaller, obtuse, instead of acute, spikelets, much narrower leaves pubescent beneath, soft-puberulent culm and panicle, secondary panicles on branches bearing close tufts of short leaves, generally smaller proportions, and greater amount of pubescence throughout.

* PANICUM BICKNELLII Nash.

A large, spreading, nearly prostrate tuft growing among *Ammophila* on a wide sandy tract on Little Neck, September 14, 1906. Spikelets remaining only on the secondary panicles.

This grass would seem to be almost out of place on Nantucket, although it is less exclusively an inhabitant of open rocky woods than has been supposed, for it occurs, also, though rarely, in open sandy fields on Long Island.

The Nantucket plant is not in the least doubtful, although the prostrate position and unusually firm and roughened leaves are noteworthy: larger culms 5 dm. long, leaves mostly 3–5 mm. wide, 6–10 cm. long, firm, scabrellous on the upper surface, becoming involute toward the apex or even narrowed to a terete attenuation, at least the lower leaves sparsely ciliate towards the base; internodes puberulent; lower nodes slightly bearded; sheaths glabrous or obscurely pubescent, the margins somewhat pilose; panicle scabrous, 6–9 cm. long; culm glabrate; spikelets 2.5 mm. long, acutish, puberulent, the nervation formula, 1, 9, 7.

* PANICUM DICHOTOMUM L.

Apparently rare, and met with only on the moors near the fifth mile post of the railroad — the common woodland plant. It appears smooth and glabrous throughout, but actually the sheaths of the short basal leaves are appressed-pilose and the lowermost internodes sometimes obscurely puberulent; there are also often a few long, erect or reflexed white hairs at the base of the leaf,

especially on the branches, where the sheaths are also sparsely pilose; leaves spreading, 2–5 mm. wide; spikelets glabrous, 2 mm. long.

* PANICUM COLUMBIANUM Scribn.

Rather common in dry open places or in partial shade among scrub-oaks and pines.

Among the related species on Nantucket, this is especially marked by the fine, close puberulence of the slender purplish internodes, which often appears more like a glaucescent bloom than a pubescence. The lowermost internodes are, however, sometimes densely appressed-pubescent, and specimens which approach *P. meridionale* in still other characters denote a very close relationship. The leaf-blades are either glabrous or close-puberulent on the lower surface; the spikelets are 1.5–1.75 mm. long.

* PANICUM MERIDIONALE Ashe.

Panicum filiculme Ashe.

Panicum oricola Hitchc. & Chase, Rhodora **8**: 208. N 1906.

Perhaps the most common *Panicum* of Nantucket, growing everywhere in dry sand or sandy soil. Its preference would appear to be for exposed sandy or gravelly levels, but it mingles freely with the close low growth which covers the moorland and hillsides and finds its way into half-shaded openings among the pine groves. Responding to this diversified habitat it shows so great a degree of variation that extreme forms might confidently be taken for distinct species. From one to another of the most divergent forms, however, gradation appears to be so complete and so general that, although not convinced of their actual interrelation, I have found no assured basis for treating them otherwise than as conditions or states of a single rather broad species.

Three pronounced variants are here especially referred to: One is the plant of exposed sandy places. It is either erect or prostrate and readily forms close mat-like tufts; the pubescence is densely appressed-pilose on the sheaths and internodes and almost velvety on the lower surfaces of the primary leaves, although the later leaves may be quite glabrous; the panicles are sometimes long-peduncled but mostly little or not at all exserted. This seems to be the plant recently described as *P. oricola* Hitchc. & Chase.

A second well-defined variant grows in weakly spreading ascending or erect tufts and is closely much-branched; the leaves are thinner, softer, and more pilose than in the plant first described and more loosely soft-pubescent on the lower surface, and the sheaths and internodes are often conspicuously and densely villous; the panicles are short-peduncled or included, usually with slender-pedicelled spikelets. Certain examples of this form are almost identical with specimens of *P. meridionale* collected by Ashe in North Carolina. Other examples seem to meet precisely the description of *Panicum unciphyllum thinium* Hitchc. & Chase, Rhodora **8**: 209. N 1906.

A third marked form is the plant of the dry overgrown commons and moorland. This corresponds closely with specimens of *P. filiculme* named by Ashe. It is much more slender than the contrasted forms, with much sparser and looser pubescence and very narrow, firm, pale-green leaves; the small panicle is commonly long-peduncled. Very diminutive forms of this occur, in which the panicle is wholly included. In this and in the form first mentioned the primary panicles have mostly lost all their spikelets before the end of August.

A study of these several forms in their early flowering stages would doubtless throw considerable light on their mutual relationships.

PANICUM UNCIPHYLLUM Trin.

Frequent or common in low grounds or grassy places. Primary panicles with few or no spikelets remaining. A reduced and slender form occurs in cranberry bogs and sandy wet places; it is more sparsely and loosely pubescent than the usual form, with the leaves narrower, firmer, and paler green.

* PANICUM TENNESSEENSE Ashe.

Included under this name are specimens of a *Panicum* very closely related to *P. unciphyllum*, which, judging from herbarium material, seems to be now quite generally referred to *P. tennesseense*. It is uncommon on Nantucket, where two definite forms are to be noted: one is rather thinly villous-pubescent and has slender ascending culms not branched from the lower nodes, and thin, rather bright-green leaves minutely but not densely pubescent on the lower surface. This was found only in woods on

Coskaty. The other form, met with sparingly at 'Sconset and Wauwinet, is more softly and densely pubescent, with firmer, duller-green leaves, sometimes 8 mm. wide, and is branched from the base and sometimes quite prostrate. In both forms the partly included primary panicles were freshly in flower.

* PANICUM ATLANTICUM Nash.

Frequent or rather common in dry grassy places, sometimes growing with *P. Scribnerianum*. After the middle of August spikelets remain only on the secondary panicles.

On Saul's Hills a greener form with unusually narrow and long-attenuate leaves was collected.

PANICUM SCRIBNERIANUM Nash.

Common in dry sandy fields; secondary panicles only.

* PANICUM SPHEROCARPON Ell.

Common in dry places; panicles often perfectly fresh.

PANICUM CLANDESTINUM L.

Locally common in low grounds but by no means generally distributed. Past flowering.

* PANICUM MATTAMUSKETENSE Ashe.

Panicum Clutei Nash.

Common in cranberry bogs and open wet places. After the middle of August few spikelets remain on the primary panicles. Very variable, either stout or slender, sometimes only 4 dm. high with leaves 4–6 mm. wide and panicles 4–6 cm. long, again 8–10 dm. tall, the leaves 10–14 mm. wide, becoming 11 cm. long, and panicles 8–10 cm. in length. On Nantucket this little-known grass is usually smaller than the same species on Long Island and in New Jersey, and differs also in a marked tendency towards firmer and paler green leaves, smaller, fewer-flowered panicles, and generally reduced pubescence. It is sometimes strongly suggestive of a modified open ground form of *Panicum boreale* Nash.

Panicum Clutei Nash has been attributed to Nantucket and held to be distinct from *P. mattamusketense* (Scribner & Merrill, Rhodora **3**: 95, 97, 119, 120. My 1901). The type specimen of the former in herb. N. Y. Bot. Garden can be distinguished by no material character from authentic examples of *P. mattamusketense* from North Carolina. The latter is somewhat more

pubescent with more densely bearded nodes but in respect of pubescence the plant is extremely variable even in the same locality, as I have repeatedly observed on Long Island, where the species is common.

* CHAETOCHLOA GLAUCA (L.) Scribn.

Common in cultivated fields and about the wharves and streets.

* CHAETOCHLOA VERSICOLOR Bicknell.

A characteristic grass of the borders of salt marshes.

CHAETOCHLOA VIRIDIS (L.) Scribn.

Rather common, mostly near cultivated ground.

* CHAETOCHLOA ITALICA (L.) Scribn.

A few plants in an old field near the town in 1899—the smaller purple-awned form.

* CENCHRUS TRIBULOIDES L.

Scattered over a sandy level near an abandoned barn at Shawkemo Spring, Sept. 11, 1907. Perhaps introduced.

ZIZANIA AQUATICA L.

Considerable growths of this grass are established on the borders of head of Hummock Pond; Miacomet Pond, 1899. Leaves 1.5–3 cm. wide; branches of pistillate part of inflorescence either ascending or appressed.

Mrs. Owen says "Probably all introduced from seed sown about 1875."

HOMALOCENCHRUS ORYZOIDES (L.) Poll.

Common in low ground.

ANTHOXANTHUM ODORATUM L.

Common and widely spread; inflorescence completely dried.

* SAVASTANA ODORATA (L.) Scribn.

Common in salt marshes along the "Creeks"; sterile culms and leaves green, the fertile culms withered, often with persisting panicles.

ARISTIDA DICHOTOMA Michx.

Very common in sterile soil.

* ARISTIDA GRACILIS Ell.

Damp roadside west of the town, 1904.

ARISTIDA PURPURASCENS Poir.

A very common and characteristic grass of dry levels and barrens.

STIPA AVENACEA L.

Dry levels near head of Tom Never's swamp, 1904; only a single spikelet found, dried and accidentally persistent; east of Almanac Pond, Sept. 1907, leaves only.

MUHLENBERGIA MEXICANA (L.) Trin.

Sparingly by borders of yards and street-sides in town — the much-branched leafy form with numerous, lateral, flattened, short-branched panicles; defined as the type of *M. mexicana* by Scribner (Rhodora 9: 18. F 1907).

M. diffusa Schreber, reported in Mrs. Owen's catalogue as having been noticed in a yard in Orange Street, should possibly be referred to the above species, which occurs in yards along this same street.

PHLEUM PRATENSE L.

Common, spikes mostly dried.

ALOPECURUS PRATENSIS L. See p. 443!

Admitted to Mrs. Owen's catalogue; I saw nothing of it.

* SPOROBOLUS VAGINAEFLORUS (Torr.) Wood.

Found only in a sandy spot about one mile out on the road to Surfside; here it was growing sparingly in 1899 and subsequent years. Comes into flower perhaps later in the year than any other grass found on the island; at the middle of September 1907 it was not yet in bloom and in other years was only beginning to bloom towards the middle of the month.

AGROSTIS ALBA L.

Common; panicles dried. The prevailing plant is the reduced state — var. *vulgaris*, which abounds on the dry commons; the typical form occurs in richer soils. A lax form having more diffuse panicles and smaller spikelets is found in damp thickets.

* AGROSTIS MARITIMA Lam.

Very common in salt and brackish meadows. The usual form often grows in close masses, has very narrow leaves, with ligules often 5 mm. long, numerous slender culms, and contracted spike-like panicles 7–10 cm. long and less than 0.5 mm. thick. A stouter

form grows in close tufts and has geniculate, spreading, or ascending culms, and much more open, interrupted panicles often 1.5 dm. long and 2–4 cm. wide. Contrasting remarkably with these is a very definitely characterized form which was collected Sept. 2, 1904, on damp sandy levels by a pond on the south shore. It had produced numerous stolon-like leafy stems which crept over the sand for a distance of 1–2 feet and bore numerous short, firm leaves and short, leafy branches springing from many of the nodes; flowering culms 1.5–3.5 dm. in length, panicles close, narrowly oblong 3 6.5 cm. long, 0.5–1 cm. thick; leaf-blades 3–5 cm. long, 1–2 mm. wide, firm, rough on both surfaces and involute-attenuate at apex, ligule 1–1.5 mm. long; inflorescence, leaf-sheaths, and culms strongly tinged with purple. This grass agrees closely with the description of *Agrostis depressa* Vasey of the Northwest Coast (see A. S. Hitchcock, U. S. Dept. Agric. Pl. Ind. Bull. **68**: 28, 29), and the illustration of a specimen from Oregon (*loc. cit. pl. 6*) would answer almost perfectly for the Nantucket plant. This plant was in fresh flower when collected, whereas in the common meadow forms the panicles were completely dried.

AGROSTIS HYEMALIS (Walt.) B. S. P.

Trichodium laxiflorum Michx.

Common in sandy damp places and pond shores. The Nantucket grass of this composite species is clearly the plant of Michaux, whatever Walter's *Cornucopiae hyemalis* may have been. It is characterized by greatly elongated panicle-branches, slender-pedicelled, not crowded spikelets, the empty glumes narrowly acuminate, 2–2.5 mm. long; flowering scale narrow, 1.25 mm. long; basal leaves numerous, setaceous; culm leaves broader, 1–2 mm. wide.

* AGROSTIS ELATA (Pursh) Trin.

Common in sphagnum bogs and wet places. A late-flowering grass, coming into bloom in late August and September, sometimes growing in close masses and becoming conspicuous from its purple panicles.

This grass seems never to become as tall and strongly developed on Nantucket as in the sandy swamps of New Jersey and Long Island, and is often a small and flaccid quite inconspicuous bog plant. In favorable situations, however, it attains a growth

which approaches typical examples of the species, the leaves becoming 2–3 mm. wide, panicles 2–3.5 dm. in length, and spikelets 3–3.5 mm. long.

This species develops slender underground rootstocks, and the culms are often branched from near the base, characters which I have not observed in the tufted, green-panicled woodland grass, *A. perennans* (Walt.) Tuckerm. (*A. intermedia* Scribn.), to which *A. elata* has been referred as a variety.

HOLCUS LANATUS L.

Scattered all over the island; inflorescence mostly dried.

AIRA CARYOPHYLLEA L.

Widely scattered over the island and locally very common: below the "Cliff," east and west of the town; on and below the bluff at 'Sconset; sandy levels about some of the ponds on the south shore. Plants dead and dried but holding many spikelets in the silvery panicles.

DESCHAMPSIA FLEXUOSA (L.) Trin.

Very common over the moorland and dry commons and abundant in the cedar barrens on Coskaty; panicles dried.

DANTHONIA SPICATA (L.) Beauv.

Very common; culms and spikes mostly dried. Among scrub pines south of the county fair grounds, a stout, strongly tufted form was collected September 2, 1904, bearing many fresh panicles. This plant appears somewhat intermediate between *D. spicata* and *D. sericea* Nutt., the sheaths and leaves being somewhat villous and the flowering scale rather densely pilose and with slender teeth 2–3 mm. long. It seems to be precisely the grass described from Long Island by Austin in 1872, as *Danthonia Alleni*. (Bull. Torrey Club **3**: 21.)

It is frequent on Long Island and I have collected a variation of it on Mt. Desert, Maine, and on Cobble Hill, Lake Placid (apparently *D. Faxoni* Austin, Bull. Torrey Club **6**: 190. 1877). The Lake Placid specimens bore perfectly fresh panicles as late in the season as October 20, 1901, although the first heavy snow had fallen two days before.

Compared with *D. spicata* in its simplest state this stouter form appears very distinct but intermediate examples everywhere

seem to bridge the differences between them. Some of the Nantucket specimens show the slender bracts at the base of the panicle-branches just as described by Austin, but the culms are not branched except that one shows a secondary panicle starting from one of the upper nodes.

SPARTINA CYNOSUROIDES (L.) Willd.

Common, sometimes occurring far from marshland on the dry commons. At Quaise and Eatfire is found a stout form having numerous crowded spikes, sometimes as many as forty, which is suggestive of *S. polystachya* (Michx.) Ell. The record of the latter from "Eatfire and elsewhere" would therefore seem to require confirmation.

* SPARTINA JUNCEA (Michx.) Willd.

Frequent or common, usually in dry white sand back of the beaches, sometimes in cranberry bogs near the shore. Later-flowering than *S. patens*, the spikes being uniformly in fresh condition at the middle of September when those of the latter are mostly dried. Certain examples suggest intergradation with *S. patens* but the plants usually appear very distinct. *S. juncea*, although sometimes closely cespitose, often produces scattered culms or only a few together from stout running rootstocks; it becomes as large as 12 dm. high with spikes 6 cm. long. Tufted forms agree closely with type material of *S. caespitosa* Eaton, but, as a rule, have less slender, more spreading leaves and larger spikes.

SPARTINA PATENS (Ait.) Muhl.

Everywhere in salt marshes.

SPARTINA GLABRA PILOSA Merrill.

Common along shores and tidal creeks.

SPARTINA GLABRA ALTERNIFLORA (Lois.) Merrill.

Specimens referred here are scarcely more than reduced states of the last, having few slender spikes of more separated spikelets, with obscurely puberulent or glabrous scales.

PHALARIS CANARIENSIS L.

Recorded by Mrs. Owen from about the old wharves, on the authority of Doctor Swan.

Phalaris arundinacea picta was observed as a mere garden

escape straying along a fence and into a low field at the edge of the town, 1904–'07.

PHRAGMITES PHRAGMITES (L.) Karst.

A considerable growth on the southwest side of Sachacha Pond; Reed Pond; boggy spot in the Woods.

* TRIDENS FLAVA (L.) Hitchc. Rhodora **8**: 210.

Tricuspis sesslerioides (Michx.) Torrey.

In an enclosed grassy lot showing sandy exposures on North Street about a quarter mile west of the Sea Cliff Inn, September, 1907. Vigorous tufts and larger groups in full flower were scattered through the lot. Probably introduced.

TRIPLASIS PURPUREA (Walt.) Chapman.

Everywhere in dry white sand on dunes and exposed places.

* **Diplachne maritima** nom. nov.

Diplachne procumbens Nash, in Britton, Man. 128. 1901, not *D. procumbens* Arech. Gram. Urug. 1894, *fide* Hitchc. U. S. Dept. Agric. Pl. Ind. Bull. **33**: 17. F 1903.

Sparingly on the shores of Sachacha Pond, 1899; in considerable abundance on the sandy shore of Miacomet Pond, 1907, a reduced form, growing in small, congested, flatly prostrate tufts 1–2 dm. in diameter: culms numerous, crowded, branched 0.5–2 dm. long; panicles 3–8 cm. long, mostly included, their branches short, appressed, 1–4 cm. long; spikes 8–10-flowered, 6–8 cm. long; flowering scales 2.5–4 mm. long, much less pilose-fringed on the margins and at the base than in the more strongly developed plant from further south, the awns 1.5–3 mm. long.

* ERAGROSTIS PURSHII Schrad.

Scattered along the sandy sides of Main Street near the edge of the town in 1899; it had spread but little in 1904 and 1906 and the following year had been nearly exterminated by the paving of the street.

ERAGROSTIS MAJOR Host.

Occasionally found by street-sides in the town and infrequent in the suburbs; a single plant at 'Sconset, 1904.

* ERAGROSTIS PECTINACEA (Michx.) Steudel.

Very common. A stouter, stiffer-leaved form with more ample

and denser panicle, and sometimes larger spikelets, in white sand among the dunes and sand wastes.

ERAGROSTIS SPECTABILIS (Pursh) A. Gray.

Frequent or common in sandy places.

DISTICHLIS SPICATA (L.) Greene.

Very common in salt marshes.

DACTYLIS GLOMERATA L.

Common, mostly in and near town and about farm lands. Inflorescence completely dried.

POA ANNUA L.

Common, some fresh panicles.

POA PRATENSIS L.

Common, panicles dried.

POA TRIVIALIS L.

Mentioned in Mrs. Owen's catalogue; I did not meet with it.

POA COMPRESSA L.

Common, panicles dried.

POA SEROTINA Ehrh.

At several places along old wharves and once by a street-side in the town.

PANICULARIA CANADENSIS (Michx.) Kuntze.

Common. A very coarse, stout form is frequent, having broad, decompound panicles, the larger leaves 12 mm. wide, the stem sometimes 1 cm. thick at base.

PANICULARIA NERVATA (Willd.) Kuntze.

Frequent; past flowering.

PANICULARIA AMERICANA (Torr.) MacM.

Uncommon; at three stations south of the town; north of the town; Polpis. Few spikelets remaining.

PANICULARIA PALLIDA (Torr.) Kuntze.

Frequent or common in ponds and pools, mostly past flowering.

* **Panicularia septentrionalis** (Hitchc.) comb. nov.

Glyceria septentrionalis Hitchc. Rhodora 8: 211. 1906.

Panicularia fluitans (L.) Kuntze, of authors, not *Glyceria fluitans* (L.) R. Br.

In pools and muddy pond-holes, not common: Wauwinet; near Reed Pond; near Tristram Coffin's homestead; roadside pool west of Maxcy's Pond. At the latter station it was freshly in flower September 14, 1907, apparently a second growth, since wherever found elsewhere it had long passed the flowering stage.

PANICULARIA ACUTIFLORA (Torr.) Kuntze.

Cato's Pond, 1899, and again 1907; this pond although named on the maps was merely a pool in a low field sometimes nearly dry in summer; roadside pool near 'Sconset; recorded from Pout Ponds. In full flower.

Puccinellia fasciculata (Torr.) comb. nov.

Poa fasciculata Torr. Fl. U. S. 1: 107. 1824.

Frequent, about the borders of salt marshes. This is the common coastwise *Puccinellia* which replaces the larger-flowered *P. maritima* (Huds.) Parl., from southern New England to New Jersey. It has commonly been referred to *P. distans* (L.) Parl., a very different plant and doubtless an introduced species in our flora. True *P. distans* is decumbent at the base and has open panicles, sometimes nearly half the length of the slender culms, formed of almost capillary widely spreading or deflexed branches sometimes 12 cm. long, in clusters of 2–5 and floriferous mostly above the middle; the spikelets are not crowded and are often slender-pedicelled, the flowering scales 1.5–2 mm. long, truncate-obtuse and rather distinctly nerved, the nerves below evidently pubescent.

In *P. fasciculata*, the culms, although often geniculate below, are not decumbent but stiffly ascending or erect, the exserted part longer than in *P. distans* and sensibly stouter and stiffer, the panicles much smaller and narrower, sometimes almost spike-like, formed of appressed or ascending stiff branches mostly single or in pairs and floriferous from near the base, the spikelets crowded, sessile or stipitate, the flowering scales 2–2.5 mm. long, acutish or obtuse, more coriaceous than in *P. distans* and less distinctly nerved, the base of the nerves glabrous or glabrate.

FESTUCA OCTOFLORA Walt.

'Sconset, along the top of the low bluff south of the settle-

ment, Aug. 30, 1904, plants dried up but with some spikelets persisting. Recorded from between 'Sconset and Sachacha.

FESTUCA MYUROS L.

Common along the railroad and in adjoining sandy fields near the town, 1906; one station near 'Sconset, 1904; plants completely dried up but many spikelets remaining.

* FESTUCA CAPILLATA Lam.

Sandy commons and pastures in the town region and on the south side of the island, stems and panicles dried but basal leaves still green.

FESTUCA OVINA L.

My collections of Nantucket plants include no specimens of true *Festuca ovina* nor have I now any quite certain recollections of having met with it. My notes, however, refer to it as having been found with spikelets nearly gone on the south pasture and in the town region. It is recorded by Mrs. Owen and is probably common.

* FESTUCA RUBRA L.

Under the currently accepted view as to what constitutes *Festuca rubra* L. in this country it is necessary to place under this name two Nantucket grasses which are quite probably distinct species. The less common one is that to which the name more properly applies, judging by comparison with presumably authentic examples of the European plant. It is a low, rather stiff grass, conspicuously blue-glaucous throughout and, although forming close tufts, develops pronounced stolons, usually short and assurgent or declined-upcurved, but sometimes more slender and 10–15 cm. in length; the basal leaves are numerous and very firm, often stiffly curved, strongly involute, 1–2 dm. long, their lower sheaths densely short-pubescent often with reflexed hairs and usually much tinged with reddish-purple; the culms are 2.5–4 dm. high, bearing panicles 5–8 cm. long, the lower branches often stiffly spreading; flowering scales scabrellous, 4.5–6 mm. long, bearing delicate awns 1–2 mm. in length. This grass was found at several widely separated localities in sandy places near the shore. It is closely matched by specimens from Nova Scotia collected by Howe & Lang, which bear labels corrected from *F. ovina* to *F.*

rubra; *no. 1568*, Halifax Harbor, Sept. 2–6, 1901, herb. N. Y. Bot. Garden, may be especially cited.

The other grass here discussed is found on the plains and commons and even far out on the moorland, where it is often to be seen rising among masses of bearberry and other low-growing plants of sandy soils. It also occurs in more strongly developed form on the borders of salt marshes. It is of either tufted or scattered habit, but possesses the character of extra-vaginal offshoots, held to be determinative of *F. rubra* among our eastern species. This character, however, is often only obscurely developed and usually takes the form of short, suberect offshoots or innovations, rather than well-defined stolons. In its commonest form, it is a very slender glaucescent grass 4–5 dm. high, the leaves of the shoots erectly clustered about the culms, very narrow and involute, 2–3 dm. long, their lower sheaths puberulent, the basal ones membranous, brownish, and distinctly veined, not broadened, pale and closely massed together as in *F. ovina*; but the flowering scales are 4.5–6 mm. long, subterete, short-awned, and often glabrous and shining, though sometimes slightly scabrellous.

Stouter forms become 6–7.5 dm. tall, with broader, less involute leaves and more open, longer-branched panicle sometimes 15 cm. long, the flowering scales 5.5–7.5 mm. in length, the empty glumes proportionately large. This grass has been frequently determined as *F. ovina duriuscula* (L.) Hack., from which it is altogether distinct. It is the *F. duriuscula* L. of Torrey's Flora of New York and is a characteristic coastwise species of Long Island and New Jersey. I am strongly of the opinion that it is a native grass distinct from true *F. rubra*. When observed on Nantucket both of these grasses were well past maturity, making impossible a thorough study in the field.

FESTUCA PRATENSIS Huds.

Streets and grassy lots in the town and in outlying fields. Probably more generally distributed, but not readily noticeable late in the season after its spikelets have fallen. *Festuca elatior* L. was not observed.

* BROMUS TECTORUM L.

A few plants on the sandy border of Mill Street not far from

the old mill, Sept. 16, 1907, some fresh panicles remaining; plants small, apparently a second growth.

BROMUS STERILIS L.

Mrs. Owen in her catalogue says that fine specimens of this grass were found near the windmill by Judge Churchill in 1886, and by herself on Fair Street the following year. It is emphasized that the grass intended is true *B. sterilis* as distinguished from *B. tectorum* which, it is said, had not at that time reached the island.

BROMUS RACEMOSUS L.

On West Center Street, Sept., 1904, a few small plants bearing fresh panicles; also on street-side in the south part of the town.

BROMUS HORDACEUS L.

Sandy field by the railroad near the town, Aug. 6, 1906, many completely dried plants; also on Mill Street with *B. tectorum*, some small, apparently second growth plants bearing fresh panicles; Shawkemo.

* BROMUS SECALINUS L.

Roadside south of the town, a single erect but dried-up culm and panicle, Aug. 5, 1906.

LOLIUM ITALICUM A. Br.

Sparingly by roadside north of the town, Aug. 4, 1906; clover field south of the town, Sept., 1907.

Lolium perenne L., as given in Mrs. Owen's list, may perhaps have referred to *L. italicum*, which had not been recognized in our flora at that time.

AGROPYRON REPENS (L.) Beauv.

Common in several of its forms, sometimes with green spikes but mostly past the flowering stage.

* AGROPYRON REPENS LITTOREUM Anders.

Sand dunes on the north shore. The plant here in view agrees closely with Scribner's description of *littoreum* in U. S. Dept. Agric. Div. Agrost. Bull. **4**: 36. It is markedly different from the abundant grass commonly assumed to be typical *repens*, but intermediate examples seem to obliterate all sharp lines of demarcation.

HORDEUM VULGARE L.

Occasionally persistent in old fields.

* **Elymus halophilus** sp. nov.

More or less glaucous, purplish-tinged, slender, erect, sometimes slightly ascending at base, after forming loose tufts, 4–7 dm. high; leaves narrow, firm, erect, those of the culm mostly 5–7, the lowest very narrow, smooth and glabrous, or slightly hairy on the upper surface near the base, narrowly attenuate, involute on the margins or throughout when dry, 2–5 mm. wide, mostly 10–15 cm. long; ligule very short; basal leaves erect, when involute appearing almost setaceous, becoming over 15 cm. long; spike erect, slender-peduncled, 4–9 cm. long, often under 1 cm. thick, the peduncles usually exserted 5–15 cm.; empty glumes 7–10 mm. or less in length, 1–1.5 mm. wide, tapering into slender rough awns of about equal length, minutely scabrous on the prominent ribs; flowering scales 6–7 mm. long, 1–1.25 mm. wide, minutely scabrellous all over, conspicuously nerved only towards the apex, tapering into slender rough awns often 1.5 cm. long.

In abundance in a salt marsh on Eel Point; also on Little Neck and sparingly near Acquidness Point.

Salt marshes and shores along the coast from Maine to New Jersey and doubtless further south. Common on Long Island. Type from Acquidness Point, Nantucket, Sept. 11, 1907, in herb. N. Y. Bot. Garden.

Differs from *Elymus virginicus* and *E. hirsutiglumis* Scribn. & Sm. in much smaller size, fewer, shorter, narrower and firmer leaves, their sheaths not inflated, smaller, more loosely flowered spike, usually glaucous and strongly purplish-tinged, shorter and more tapering flowering glumes bearing much longer, stiffer awns, scabrellous and long-awned flower-scales.

The genus Ernodea Swartz : a study of species and races*

NATHANIEL LORD BRITTON

This genus of Rubiaceae was established by Swartz† on a single species, *E. littoralis* Sw., from the island of Jamaica. It has recently been regarded as monotypic, consisting only of the type species, which is widely distributed in the Caribbean region, in Jamaica, Florida, the Bahamas, and from Santo Domingo to Guadeloupe. I do not find the genus reported from Cuba, though it almost certainly exists there and further exploration will probably reveal it. Attempts have been made to refer to *Ernodea* plants now relegated to the genus *Putoria* of the Old World and to *Isidorea* of the West Indies.

In 1905 Dr. Small characterized *Ernodea angusta*‡ from pinelands in southern Florida, and in the same year I described *Ernodea Cokeri*§ found among the collections made by Professor Coker on Abaco Island during the Bahamian exploration organized by the Geographical Society of Baltimore. The Bahamian explorations conducted by the New York Botanical Garden and the Field Museum of Natural History have revealed the existence in the Bahamas of several additional species with apparently numerous races, the genus evidently having its greatest development in these islands. These explorations have afforded convenient opportunity for field study of the plants.

The shrubs form colonies sometimes of large size, spreading from underground parts so as to clothe densely the sand or rocks on which they grow. So far as our observation goes, they are confined to limestone rocks or limestone sand. That mutation takes place freely is indicated by the fact that in the Bahamas, at least, one colony will often differ from another near by in some

* This treatment of a genus will serve to illustrate the propositions advanced by the writer in the symposium on "Aspects of the Species Question," at the meeting of the Botanical Society of America, Chicago, January, 1908.

† Prodr. 29. 1788.

‡ Bull. N. Y. Bot. Gard. 3: 438.

§ In Shattuck, The Bahama Islands, 264, Botany by W. C. Coker.

minor character, such as leaf-form, tint of the corolla, prostrate or bushy habit. That such small characters are transmittable by seed is also evidenced by plants with identical features forming colonies at some distance from each other, and too far apart to have been produced by underground connection. The small fleshy yellow fruits of these plants are probably freely distributed by birds.

The numerous specimens now in the herbarium of the New York Botanical Garden seem to me to fall into six species, composed of a considerable number of races. Characters taken as specific are indicated by the following key:

Calyx-lobes varying from nearly as long as the fruit to longer.
- Leaves lanceolate to oblong, oblanceolate or oblong-lanceolate, 5–10 mm. wide.
  - Corolla white to pink; leaves relatively broad; plant mostly of coasts. 1. *E. littoralis.*
  - Corolla red to scarlet; leaves relatively narrow; plant mostly of pine-lands. 2. *E. angusta.*
- Leaves narrowly linear, 1–3 mm. wide. 3. *E. Cokeri.*

Calyx-lobes much shorter than the fruit.
- Leaves oblong-lanceolate, 6–8 mm. wide. 4. *E. Millspaughii.*
- Leaves narrowly linear to linear-oblanceolate, 1–3 mm. wide.
  - Leaves bristle-tipped; calyx-lobes half as long as the fruit. 5. *E. Taylori.*
  - Leaves merely mucronate; calyx-lobes one third as long as the fruit. 6. *E. Nashii.*

1. ERNODEA LITTORALIS Sw. Prodr. 29. 1788

The first mention and illustration of this type species of the genus was by Sir Hans Sloane in his Natural History of Jamaica, where he denominated it "Thymelaea humilior foliis acutis atrovirentibus" and illustrated it on his plate 189, figs. 1 and 2. By Patrick Browne, in History of Jamaica 140, it was referred to *Knoxia*, an East Indian genus established by Linnaeus in 1753. Jamaica is therefore the type locality of the species. I observed this plant, in company with Mr. William Harris, in September, 1907, at two points on the southern coast of Jamaica, where it grows prostrate on limestone rocks and sand. It has narrowly oblong to oblong-lanceolate entire sharp-pointed leaves, 4–8 mm. wide, the subulate stipules about 1.5 mm. long; the linear-lanceolate calyx-lobes are here just about as long as the fruit, but they evidently vary from

somewhat shorter to somewhat longer. The distribution of this typical race is illustrated by the specimens cited as follows:

JAMAICA: Pedro Bluff (*Britton 1247; Harris 9719*); coastal rocks, near Black River (*Britton 1365*); rocky hillside, Great Goat Island (*Britton 1884*).

FLORIDA: Key West (*Blodgett*); Sarasota Keys (*Garber*); Indian River (*Curtiss 1117*); Sugar Loaf Key (*Pollard, Collins, & Morris 54*); Longboat Key (*Tracy 6752, 7496*); Miami (*Small & Nash 27*); Bull Key (*Small 629*); Virginia Key (*Britton 109*); beach opposite Miami (*Small 2152*); pinelands, Miami (*Britton 462*).

BAHAMAS: Great Bahama (*Britton & Millspaugh 2373, 2707*); Abaco (*Brace 1806; E. angusta* Small?); Andros (*Brace 6770*); Harbour Island (*Mrs. Britton 6380, 6414*); Eleuthera (*Britton & Millspaugh 5410*); Crooked Island (*Brace 4606, 4624*); Long Cay (*Brace 4069*); Acklin's Island (*Brace 4282*); Rum Cay (*Brace 3943*); Green Cay (*Coker 244*); Mariguana (*P. Wilson 7456*); Great Ragged Island (*P. Wilson 7880*).

SANTO DOMINGO: (*Wright, Parry, & Brummel 220*).

PORTO RICO: Sand dunes, Santurce (*Heller 64; Millspaugh 266*); Mayagüez to Joyua (*Underwood & Griggs 185*); Island of Culebra (*Britton & Wheeler 205*).

ST. CROIX: (*Hansen 155*).

GUADELOUPE: Calcareous rocks, Desirade (*Duss 2772*).

Race 1. Leaves narrowly linear-oblong, glandular-serrulate; twigs glabrous; calyx-lobes as long as the fruit or a little longer.

BAHAMAS: Cockburn Town, Watling's Island (*Britton & Millspaugh 6075*, type; *P. Wilson 7210*).

Race 2. Leaves broadly linear-oblong, 8–10 mm. wide, glandular-serrulate; calyx-lobes a little longer than the fruit. Shrub 1.3–1.6 m. high!

BAHAMAS: Miner's Tent to Balsam Hill, Inagua (*Nash & Taylor 1274*). This is the most vigorous development of the genus that has come to my attention, and has claims for recognition as a species.

Race 3. Leaves essentially of the typical race, but glandular-serrulate; twigs densely glandular-puberulent; calyx-lobes long.

BAHAMAS: Blakesville, Inagua (*Nash & Taylor 1105*). The specimen is in flower.

Race 4. Leaves large, lanceolate or oblong-lanceolate, taper-

ing upward from below the middle, 6 cm. long, 1 cm. wide, entire-margined; calyx-lobes a little longer than the fruit.

BAHAMAS: Swamp, road to Stopper Hill, Crooked Island (*Brace 4807*). This is the only specimen known to me to grow in swampy ground.

Race 5. Leaves relatively thin, linear-oblong, entire-margined; calyx-lobes very narrow, 1.5 times as long as the fruit.

ST. CROIX: Pinetree Bay (*A. E. Ricksecker 333*, type).

PORTO RICO: Limestone hills three miles west of Ponce (*Heller 6243*).

There is no doubt that if plants here included in the typical race could be grown from seed, side by side, additional races to those here defined would be indicated by differences which herbarium specimens do not exhibit.

The typical race usually grows within the reach of ocean spray, accompanied by distinctively halophytic plants.

2. ERNODEA ANGUSTA Small, Bull. N. Y. Bot. Gard. **3**: 438. 1905

This pine-barren plant of southern Florida was proposed by Dr. Small as a species distinct from *E. littoralis* on account of its smaller flowers and narrower leaves. He described the flowers as whitish; they are pink or red, though the albino condition may, likely enough, exist. My observations do not bear out the original observation that the flowers are necessarily smaller than those of *E. littoralis*, and plants of that species sometimes bear leaves as narrow as those of Dr. Small's type specimen, while red-flowered plants existing on the northern Bahama islands, while mostly narrow-leaved, like the type, sometimes bear broader leaves. It is an interesting circumstance that plants conforming to the type in both characters occur throughout the area of *Pinus caribaea* Morelet in South Florida and the northern Bahamas, almost though not quite to the exclusion of typical *E. littoralis*, as though the pine-land condition suited *E. angusta*, considered either as a species or as a race of *E. littoralis;* this is an ecological feature of extreme interest, especially as there are a number of other species or races which give character to these pine-lands. *E. angusta* apparently extends to the coasts where pine-lands are near by, or where

pine trees formerly grew. The following specimens have been examined:

FLORIDA: Between Cutler and Longview Camp (*Small 870*); below Cutler (*S. H. Richmond*); beach opposite Miami (*Small 2157*); near Silver Palm School (*Small 2260*); near Long Prairie (*Britton 191*); Boca Grande Key, Marquesas Group (*Lansing 2276; E. littoralis?*).

BAHAMAS: New Providence (*Northrop 102; Cooper 58; Coker 63; Britton & Millspaugh 2099*); Andros (*Brace 4958, 5120, 5167, 5319, 6867, 6993, 7084*).

Race 1. Leaves relatively twice as wide as in the typical race; corolla bright-scarlet. This inhabits Garden Cay at the western end of the Great Bahama Island (*Brace 3662*); it may be better regarded as a scarlet-flowered race of *E. littoralis*.

3. ERNODEA COKERI Britton; Coker in Shattuck, The Bahama Islands 264. 1905

Occurring at the northern and northeastern range of the genus, this species exhibits the narrowest leaves of any, these being mostly only 1.5 mm. wide or less. So far as known it is confined to Abaco and the Great Bahama, growing in pine-lands and in scrub-lands where pines evidently formerly existed. Its flowers are apparently red or pink. I have seen the plant growing on the Great Bahama Island, but not in bloom; its aspect and habit are very characteristic there, it forming a trailing vine, a meter long or more.

BAHAMAS: Abaco (*Coker 564; Brace 1805, 1821*); Great Bahama (*Britton & Millspaugh 2370*).

Race 1. Leaves twice as wide as typical, approaching in size and form those of *E. angusta*. On sand dunes, Barnett's Point, Great Bahama (*Britton & Millspaugh 2681*).

4. **Ernodea Millspaughii** sp. nov.

A shrub, 6–12 dm. high, the twigs and leaves glabrous. Leaves oblong-oblanceolate, sharply pointed, 2–3 cm. long, 5–8 mm. wide, similar to those of *E. littoralis*, the short broad stipules cuspidate; flowering calyx obovoid, about 3 mm. long, the triangular lobes only one fifth to one fourth as long as the ovary; corolla white, 1 cm. long, its lobes about one half as long as the tube; fruit nearly oval, 5 mm. long, the calyx-lobes triangular-lanceolate, 1.5–2 mm. long.

BAHAMAS: Sand dunes, Clarence Town, Long Island, March 16–19, 1907 (*Britton & Millspaugh 6249*, type); Grand Turk (*Nash & Taylor 3801*). The Grand Turk specimens differ from the type in having calyx-lobes a little longer and narrower and approach the plant of Great Ragged Island (*P. Wilson 7880*), *E. littoralis*. This might be regarded as a race of *E. littoralis* with short calyx-lobes.

5. **Ernodea Taylori** sp. nov.

Spreading, with long slender branches, glabrous. Leaves narrowly linear, stiff, 1.5–2.5 cm. long, 1.5–2 mm. wide, revolute-margined, spinulose-tipped, the stipules triangular-subulate; flowers not seen; fruit golden-yellow, oval, 5 mm. long, the calyx-lobes narrowly linear, 2 mm. long.

BAHAMAS: In white land, Tenados, Inagua, Oct. 14, 1904 (*Nash & Taylor 1024*).

The foliage resembles that of *E. Cokeri*, but the calyx is altogether different.

6. **Ernodea Nashii** sp. nov.

Prostrate, glabrous throughout, the branches 6 dm. long or more, the branchlets erect or ascending, 0.5–2 dm. high, the twigs very densely clothed with leaves. Leaves linear-oblanceolate, leathery in texture, 2–2.5 cm. long, 2–3 mm. wide, mucronulate; flowering calyx 4.5 mm. long, its lobes acute, 1.5 mm. long; corolla 1.5 cm. long, its lobes white within, brown without, about one third as long as the tube; fruit ovoid-oval, 5 mm. long, the persistent acute calyx-lobes 1.5 mm. long.

BAHAMAS: Little Inagua, Moujean Harbor (*Nash & Taylor 1193*, type); west end of Little Inagua (*P. Wilson 7782*).

The development of the embryo-sac and embryo of Potamogeton lucens

MELVILLE THURSTON COOK

(WITH PLATES 9 AND 10)

The purpose of this study was to compare the development of the embryo-sac and embryo of this plant with those of other well-recognized monocotyledonous plants and with the Nymphaeaceae; also for the purpose of comparison with Holferty's (9) paper on *Potamogeton natans* and Wiegand's (14) paper on *P. foliosus*. This became especially important since the two authors differed so widely in their conclusions concerning the development of the embryo-sac. My own results are somewhat different from either and it has been possible to carry the study of the embryo further. It, therefore, seems advisable to publish the results at this time.

The material for this study was collected in a large lagoon near San Antonio de los Baños in the Province of Havana, Cuba. It was killed and fixed in the following preparations:

1. Chromo-acetic solution,
   - Water . . . . . 99 c.c.
   - Glacial acetic acid . . . . . .3 c.c.
   - Chromic acid. . . . . .7 gram.
2. Picro-acetic solution,
   - (*a*) Saturated aqueous solution of picric acid . . . . . 99 c.c.
   - Glacial acetic acid . . . . . 1 c.c.
   - (*b*) Saturated 70 per cent. alcoholic solution of picric acid . . . 99 c.c.
   - Glacial acetic acid . . . . . 1 c.c.
3. Sulphuro-acetic solution,
   - (*a*) Saturated aqueous solution of picric acid . . . . . 98 c.c.
   - Sulphuric acid . . . . . 2 c.c.
   - (*b*) Saturated 70 per cent. alcoholic solution of picric acid. . . 98 c.c.
   - Sulphuric acid . . . . . 2 c.c.

All these preparations were quite satisfactory but the picro-acetic preparations were the best and the aqueous solution better than the alcoholic.

The greater part of the work was done in the laboratory of the New York Botanical Garden and specimens of the plant have been deposited in the herbarium of that institution.

I was unable to follow the origin and development of the archesporium satisfactorily and therefore begin my discussion with the functional megaspore, which is very conspicuous and located some four to six layers of cells below the surface of the ovule (*figure 1*). It grows rapidly and develops into the normal eight-nucleate sac (*figures 2, 3, 4*). In the four-nucleate stage (*figure 3*) the sac is considerably larger at the synergid than at the antipodal end and agrees quite well in shape with Wiegand's figure 19. The two nuclei of the synergid end are placed at right angles to the long axis of the sac and ovule, while the two in the antipodal region are placed in the same direction as the long axis. The nuclei of the synergid end divide a little in advance of those of the antipodal end. A number of preparations in this stage were examined but in no case was there a common membrane around the cells in the synergid end previous to fertilization as described by Wiegand. In the eight-nucleate stage the nuclei are perfectly clear and well defined (*figure 4*). The two synergids and egg are quite large, and each is surrounded by a delicate membrane. The three antipodals are relatively large and have well-defined walls. They were never observed in a well-defined pocket as described and figured by Wiegand and by Holferty. The polar nuclei are somewhat smaller than in most plants which the writer has examined. They unite about the middle of the sac in the usual manner (*figures 4, 4a*). The fertilization of the egg was not observed but the union of the two polar and one male nucleus was observed once (*figure 4b*). Other preparations apparently showed the same thing but upon this point the writer could not be positive.

After a union of the two polar nuclei the newly formed endosperm nucleus increases in size rapidly and passes into the antipodal end of the sac (*figures 5, 6*). In the meantime the antipodal cells disintegrate and disappear entirely (*figure 6*), the young unicellular embryo (or pro-embryo) increases in size rapidly while the synergids gradually disintegrate (*figures 5, 6, 7, 8, 9*). At this time the general appearance of the sac is strikingly similar to that shown in Wiegand's figure 20.

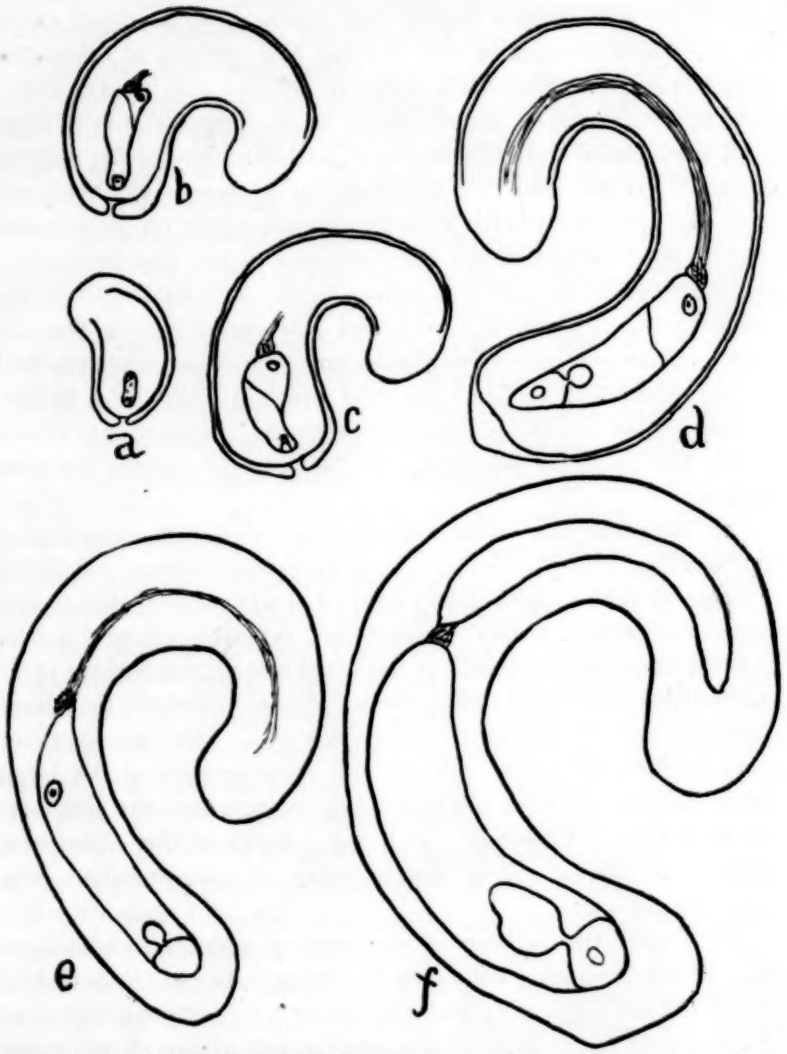
The primary endosperm nucleus now divides into two daughter-cells which are immediately separated by the formation of a wall across the sac (*figure 7*). The daughter-nucleus on the synergid

side of the wall divides rapidly and produces an abundant endosperm, which is usually non-cellular and parietal in character (*figure 12*), but occasionally becomes cellular and fills the entire sac (*figure 13*). The sac increases in size, especially in its long axis, the nucellar tissue bounding it gradually undergoing disintegration. At the same time the daughter-nucleus in the antipodal end, which, in accordance with my second paper on Nymphaeaceae, I shall designate as the "nucleus of the nucellar tube," increases rapidly in size and moves farther and farther from the partition-wall (*figures 9, 10, 11,* and *text-figures a–f*). This increase in size and activity continues until the embryo has reached the age indicated in *figure 22*, after which it undergoes disintegration (*figure 11*) and gradually disappears. Some time previous to this the partition separating the two ends of the sac has also disappeared.

At about the time of the disintegration of the large nucleus of the nucellar tube the endosperm is very conspicuous, consisting of large spindle-shaped cells (*figure 12*) which stain deeply and frequently contain several nucleoli and evidently are very active. In most cases they are without cell-walls and form a parietal layer one to three cells thick lining the sac, but occasionally they have cell-walls and fill the entire sac (*figure 13*). With the breaking down of the wall across the sac and disintegration of the large cell of the nucellar tube the endosperm extends into the antipodal end of the sac. Coördinate with the activity of the endosperm there is a corresponding disintegration of the nucellar cells bounding the sac.

Soon after the division of the primary endosperm-nucleus a mass of small nucellar cells may be distinguished at the antipodal end of the sac (*figure 14* and *text-figures b–f*) and from this mass of cells there extends to the chalazal region a core of elongated cells which eventually disintegrate, leaving a large third chamber which is separated from the true embryo-sac. It is probable that this sac finally becomes a part of the embryo-sac and is occupied by the cotyledonary end of the embryo.

The gradual increase in size and the modifications in the shape of the ovule and sac are shown in *text-figures a* to *f*. *Figure a* corresponds to *figure 9*; in *figure b* the sac is somewhat larger



FIGS. *a–f.* Diagrammatic drawings showing the shape and relative sizes of the embryo-sac, embryo, and ovule at various stages of their development. Also, the wall across the sac in *a*, *b*, *c*, *d*; the mass of small nuclear cells at the antipodal end of the sac in *b*, *c*, *d*, *e*, *f*; the core of elongated cells in *d* and *e*; and the third chamber in *f*.

and the mass of small nucellar cells is quite prominent; in *c* the sac is still larger and the embryo is in the stage corresponding to *figure 15*; in *d* both the sac and the embryo are very much larger, the embryo at this time being about the age indicated in *figure 21*;

in *e* the sac has increased somewhat in size, the partition-wall has disappeared, the large tube-nucleus has reached its maximum in both size and activity and the embryo is about the same age as in *figure 22;* in *f* the sac is very much enlarged and the new chamber at the chalazal end of the sac has developed, the embryo at this time being about the same age as in *figure 24*.

The formation of a wall across the embryo-sac separating the two daughter-nuclei formed by the first division of the primary endosperm-nucleus has been observed in many plants. It occurs in both dicotyledonous and monocotyledonous families but further studies will probably show marked differences in its behavior in these two main groups of angiosperms.

The embryo-sac of *Alisma Plantago* (now known as *Alisma Plantago-aquatica*) as described by Schaffner (12) corresponds in most respects to that of *Potamogeton lucens*, although he did not observe the formation of a wall after the division of the primary nucleus. However, in his later work on *Sagittaria variabilis* (13), (now known as *Sagittaria latifolia*) he describes a sac which corresponds remarkably well to that of *P. lucens*, with the exception that the antipodals are more persistent and that the nucleus of the nucellar tube has a tendency to fragment.* It is possible that further study of *Alisma Plantago-aquatica* will also show the formation of a wall across the sac. My own studies on Nymphaeaceae show the same formation of a wall across the sac separating the two daughter-nuclei of the primary endosperm-nucleus, the daughter-nucleus in the synergid end of the sac giving rise to the endosperm and the daughter-nucleus in the antipodal end passing into a tube or saccular structure (differing somewhat in different genera) formed by disintegration of the nucellar tissue. The behavior of this nucleus of the nucellar tube of the genus *Nymphaea* was more nearly like that of *Potamogeton lucens* than that of any other genus. In fact the general appearance, history, and behavior of these structures in *P. lucens* and in *Nymphaea* are strikingly similar. Johnson (10) describes a similar condition in *Saururus cernuus*, which is very similar to that described by me for

* Schaffner's studies on *S. variabilis* were verified by my own studies on *S. lancifolia* with the exception that I found the antipodals of *S. lancifolia* not so persistent as in *S. variabilis*.

Castalia ampla in my paper on Cuban Nymphaeaceae (5). Coker (3) describes a somewhat similar condition for certain of the Pontederiaceae except that he describes the daughter-nucleus in the antipodal end of the sac as going through a series of divisions to form an endosperm. Campbell (1) reports the presence of a large cell in the antipodal end of the embryo-sacs of *Naias flexilis* and *Zannichellia palustris* but did not determine its origin in either case. However, he states that this cell does not divide, but that in *Zannichellia palustris* "it looked as if it were undergoing disintegration," and that in both plants the endosperm arises in the synergid end of the sac. Hall (8) in his studies on *Limnocharis emarginata* reports a single antipodal cell and a single polar cell which is formed in the micropylar end of the sac; this single polar cell divides and behaves in the same manner as the primary endosperm in the Nymphaeaceae, *Sagittaria*, and *Potamogeton lucens*. This embryo-sac is so remarkable in character and so unlike any other known at this time, while the behavior of the polar nucleus is so similar to the primary endosperm of the plant just referred to, that one is justified in saying that the union of the two polar nuclei may have been overlooked. Wiegand (14) in his studies of *Potamogeton foliosus* describes a peculiar seven-nucleated sac in which but three nuclei (the egg and the two synergids) are formed at the micropylar end of the sac, the polar nucleus from the antipodal end of the sac dividing and behaving similarly to the primary endosperm-nucleus in Nymphaeaceae, *Sagittaria*, and *P. lucens*. Holferty (9) in his studies of *Potamogeton natans* describes a normal eight-nucleated sac. He failed to find a wall across the sac at any stage of its history. He did not trace the development of the endosperm but reports a very large nucleus near the antipodal end of the sac, concerning which he says "Its origin could not be determined, but it seems reasonable to consider it a derivative of the primary endosperm-nucleus, and possibly the lower nucleus of the first division, as in *Sagittaria* and *Potamogeton pauciflorus*." In the light of these later studies it seems possible that Wiegand may have overlooked the formation of the eight-nucleate sac. Aside from the fact that the antipodal cells of *Potamogeton foliosus* are evidently more persistent than those in *P. lucens*, his figure 20 corresponds quite well with *figures 5* and *6* of this paper, his figure 21 with

my *figure 7*, his figure 23 with my *figure 8*, and his figure 24 with my *figure 9*. It is well known that there may be considerable variation between genera of the same family and also some variations between species of the same genus. This question of the variation and constancy of characters between closely related species, genera, and families is of sufficient importance to demand the attention of students of this subject.

That this large nucleus of the nucellar tube performs a very important function in the nourishment of the endosperm and embryo appears self-evident at this stage of our knowledge. The writer has previously discussed this phase of the subject in papers on Nymphaeaceae (4, 5). Its morphological significance is somewhat uncertain. In my first paper on Nymphaeaceae (4) I expressed the opinion that this might be of some importance in determining the close relationship of the Nymphaeaceae with monocotyledonous plants in the series Helobiae. The phylogenetic importance of these morphological characters was denied by Johnson (11) but since that time the family Piperaceae, on which he made his studies, has been placed by the taxonomist as the lowest of the dicotyledonous families. The writer believes that we do not have sufficient data to draw very definite conclusions but wishes to emphasize the importance of further studies in these families.

THE EMBRYO

The general development of the embryo is in accordance with the *Alisma* type and bears a very striking resemblance to the embryo of *Sagittaria variabilis*. The young embryo increases in size but is very slow in undergoing its first division (*figures 5, 6, 9*, and *text-figures a, b, c*). A comparison of figures indicates that the first division of the embryos of *Potamogeton foliosus* and *S. variabilis* occurs earlier than in the embryo of *P. lucens*. After the first division the basal cell grows rapidly and forms a very thick cell-wall and is very similar to the basal cell of *Sparganium*, *Zannichellia*, *Naias*, *Triglochin*, *Limnocharis*, and *Potamogeton foliosus* and *P. natans* (*figures 15, 18, 23*). It contains an abundance of protoplasm, stains deeply, and gives every evidence of great activity until the appearance of the cotyledon, when it first shows signs of disintegration.

The number of cells in acropetal succession may be six in number. When three cells are formed the apical cell divides by the formation of two longitudinal walls at right angles (*figure 15*) and this is followed by cross and longitudinal divisions of the second and third cells (*figures 16, 17, 19, 20, 21*). Thus far the formation of the embryo is in harmony with the descriptions given by Wiegand and Holferty for *P. foliosus* and *P. natans.*

The further development of the embryo shows some variations at this point, in some cases showing three well-defined segments (*figures 18, 19, 21*), while in others it showed only two, as indicated in *figure 20.* The writer is unable to say positively whether the formation of the parts is strictly in accordance with the *Alisma* type or whether there is a variation as described by Campbell (1) for *Zannichellia,* but is inclined to the former view, which is assumed to be true in the further discussion of this subject. It will be noted at this time that *figure 20* corresponds quite well to Wiegand's figure 26.

The apical cell, as previously stated, divides and eventually gives rise to the cotyledon. The second cell divides by a cross-wall; of these two daughter-cells the one next to the apical cell divides, forming a second segment from which is derived the apex of the stem. The other daughter-cell forms the third segment and part of the suspensor by which the embryo is attached to the large basal cell. From this third segment are derived the hypocotyl and the root-tip. These three segments are shown in *figures 18, 19,* and *21.* Cell *a* of *figures 18, 20,* and *21* divides transversely into cells *a* and *a'* of *figure 22.* Cell *a* of *figure 22* evidently forms in part or entirely the dermatogen of the root-tip (*figures 23, 24*), while *a'* of *figure 22* divides to form cells *a'* and *a''* of *figure 23.* Cell *a'* of *figure 23* now undergoes division to form the calyptrogen, as shown in *figure 24,* while cell *a''* becomes a part of the suspensor. Shortly after this, the plerome and periblem show indications of differentiation (*figure 24*).

As previously stated, with the appearance of the cotyledon (*figure 23*) the large vesicular basal cell of the suspensor shows signs of disintegration. The suspensor is always delicate and the embryo even in its early stages is frequently found separated from the basal cell.

SUMMARY

1. The formation of the embryo is regular and typical.

2. The primary endosperm-nucleus divides and the two daughter-nuclei are separated by a wall. The one in the synergid end of the sac gives rise to the endosperm while the one in the antipodal end grows rapidly, is very active, and moves downward into an extension of the sac formed by the disintegration of the nucellar tissue, where it finally undergoes disintegration.

3. The endosperm is conspicuous, usually parietal and nuclear, without cell-walls.

4. The embryo follows the *Alisma* type in its development.

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Explanation of plates 9 and 10

Figures 1 to 13 were made with Bausch & Lomb 1-inch eye-piece and 1/12 oil-immersion objective. Figures 14 to 24 were made with same eye-piece and 1/6 objective. All have been reduced somewhat more than one half in reproduction.

FIG. 1. Functional megaspore.

FIG. 2. Two-nucleate sac.

FIG. 3. Four-nucleate sac.

FIG. 4. Eight-nucleate sac.

FIG. 4a. Complete union of the polar nuclei.

FIG. 4b. Union of polar nuclei and male nucleus.

FIG. 5. Sac soon after fertilization.

FIG. 6. Sac soon after disintegration of the antipodal cells.

FIG. 7. Sac soon after first division of the primary endosperm-nucleus.

FIG. 8. Sac soon after first division of the nucleus in the antipodal end of the sac.

FIG. 9. Sac showing increase in endosperm growth of the nucellar tube nucleus.

FIG. 10. Nucellar tube nucleus at its maximum in size and activity.

FIG. 11. Nucellar tube undergoing disintegration.

FIG. 12. Typical endosperm-cell without walls.

FIG. 13. Unusual endosperm-cell with walls.

FIG. 14. Mass of nucellar cells at the antipodal end of the embryo-sac.

FIG. 15. Young embryo after first longitudinal division of the apical cell.

FIG. 16. Young embryo slightly older than in Fig. 15.

FIG. 17. Young embryo slightly older than in Fig. 15.

FIG. 18. Young embryo, showing three segments.

FIG. 19. Young embryo, showing three segments, slightly older than in Fig. 18.

FIG. 20. Young embryo, rather unusual form.

FIG. 21. Spherical embryo, showing three segments.

FIG. 22. Spherical embryo, showing three segments, slightly older than in Fig. 21.

FIG. 23. Embryo, showing the cotyledon and also the large vesicular basal cell in first stages of disintegration.

FIG. 24. Embryo, showing differentiation of tissues.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1908)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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